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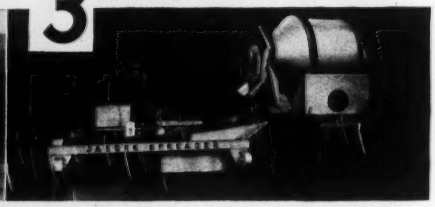

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Hazardous Tunneling at Hetch Hetchy

Present operations on Coast Range tunnels for San Francisco water supply require special methods for combating gas hazard—Sublining of pneumatically sprayed concrete replaces timbering in squeezing ground

SAFETY precautions required by gaseous rock strata have made driving operations on the last section of 28.6 miles of the Coast Range tunnel for the Hetch Hetchy water-supply system of San Francisco, Calif., comparable to coal-mining procedure. The changes in methods include the use of "permissible" electrical equipment, safety electric cap lamps and explosives. besides a fire boss continually on duty in each heading and a complete rearrangement of the ventilating system. The heavy squeezing ground encountered along an extended section of the tunnel has also necessitated the substitution for timbering of pneumatically sprayed (Gunite) sublining directly behind the face. These two developments make the present operations distinctly different from the methods employed in the early stages of the work, which were described in *Engineering News-Record*, Jan. 15, 1931, p. 96. The general features of the Hetch Hetchy project have been described in *Engineering News-Record*, April 19, 1928, p. 614, and Jan. 31, 1929, p. 171.

Briefly, the tunnel is a 28.6-mile bore with 10½-ft. inside diameter and 250-m.g.d. capacity. It pierces the Coast Range directly east of the southern end of San Francisco Bay and is the last major tunnel unit of the initial construction work. The ultimate plan proposes a similar and parallel tunnel 175 ft. south of the present line, when additional capacity is required. The existing shafts, being located on cross-cuts between the two tunnel lines, will be available for use on the future construction without interference with service.

Typical shaft camp along Coast Range tunnel of Hetch Hetchy water supply for San Francisco. The hills are of sedimentary formation with carboniferous strata that produce gaseous conditions in the tunnel.

The Coast Range formation is sedimentary, consisting mainly of sandstone and shale of varying degrees of hardness. Some of the strata are slightly carboniferous, and veins of inferior coal were mined in this general region in the early days. Water is present in varying quantities, softening the material and increasing driving difficulties. Some of the strata have a tendency to slake upon exposure to air.

Although occasional streaks of hard rock, mostly schist, are encountered on the tunnel line, the greater portion is material softer than ordinary sandstone and shale. Hydrogen sulphide gas has been found in small quantities at various points. In addition, the material has a tendency to squeeze and move after the tunnel is opened. This effect is relatively slow and involves no particular danger, but in some sections it has necessitated extensive maintenance work even where timbering was increased to 16x24 in. This difficulty was met by the use of sublining, as described later.

Driving was commenced in 1928 at the portals, and the work from the first shaft headings started in October, 1928, and from the last heading in February, 1930. During the summer of 1930 methane was encountered at several locations. Realizing the danger, all ordinary precautions were observed in carrying forward the work, but a serious explosion occurred in July, 1930, resulting in several deaths. As a result of this accident, the work was stopped on all sections of the tunnel known to be gaseous until equipment and methods could be changed to satisfy U. S. Bureau of Mines standards for coal-

A fire boss is on constant duty in every gaseous heading and is equipped to determine the presence and amount of gas. The fire boss also controls all blasting operations.

mine operation. These changes required about six months to complete, in addition to slowing up the work since that time as the result of the slight decrease in efficiency. The actual expenditure required for providing new "permissible" equipment (approved by the U. S. Bureau of Mines for use in gassy mines) has been $200,000. This does not include any allowance for lost time or delay.

Ventilating system changed

Because gas difficulties have been most severe in the central portion of the tunnel, where operations are conducted from shafts varying from 300 to 800 ft. deep, the original plan for ventilation from the shafts provided for positive pressure blowers forcing air to the faces through 24-in. ventilator pipes. The blowers are designed for pressures up to 4 lb. per sq.in. This method, rather than suction, was the logical ventilating procedure for ordinary ground, as it gave fresher, cooler and drier air at the face. Blowing was maintained continually, with the exception of a few minutes directly after shooting, when the air current was reversed for several minutes to assist in clearing the heading.

Upon the introduction of the additional safety measures in 1930 the government regulations required an exhaust system of ventilation. The main advantage of this method is to clear the face of possible gas more rapidly and keep a fresher supply of air through the tunnel to the face. The disadvantage is higher temperature, a poorer quality of air at the face and more humidity picked up by the incoming air current passing along wet places in the tunnel. Lately a system of blowing cool, dry air into the face through a 24-in. pipe and exhausting the warm and gaseous air out through another 24-in. pipe has been resorted to to reduce humidity.

In addition to the main exhaust pipe, sucker pipes are placed at locations where gas is known to occur; these pipes lead into the main 24-in. pipe. Also, baffles of sheet metal are set on the timbering to deflect the incoming air currents and sweep out possible gas pockets. Aside from the poorer quality of air at the face, the system has been effective for its intended purpose. The principal mechanical change required has been to strengthen the ventilator pipe to protect it against collapse under a possible 4-lb. exhaust pressure. Angle-iron bands were applied as required; ordinarily three bands were applied per 20-ft. length of pipe, but near the shafts the number was increased to five.

Light and power circuits changed

The change in regulations required the entire elimination of the lighting and power circuits in the tunnel. The headings and the tunnel had been illuminated with electric lights. At present the only light provided is the safety-battery cap lamps of the men and the headlights of the locomotives. The remaining miles of the tunnel are dark. Where there is a concentration of work, as at the face, permissible storage-battery floodlights are used. Also an exception is allowed at the station at the bottom of the shafts where pumping and hoist loading is in progress. Here 110-volt lights are permitted, although the globes are inclosed in heavy vapor-proof outer globes and wire protectors.

Decreased efficiency resulting from this reduced illumination for driving and other operations is not capable of definite appraisal. A very definite result, however, has been an increase in minor accidents attributed to poor light in such operations as car coupling.

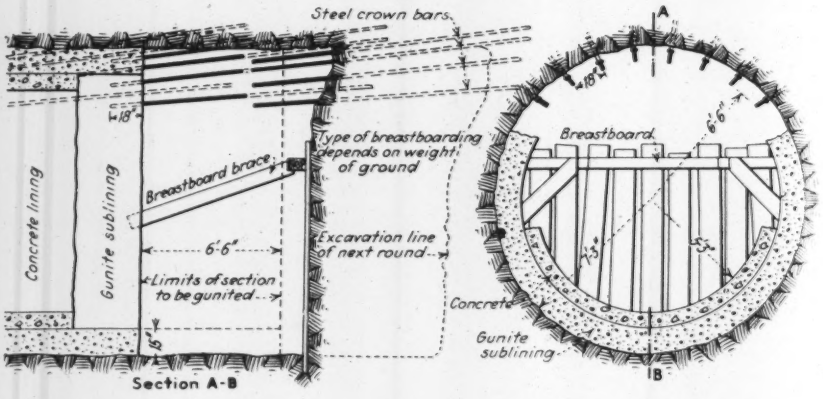
The only electric wires carried to the face are for telephone service and blasting. Water pumps and mucking machines are air-operated. The storage-battery locomotives for hauling are all of the permissible type. Crews are not allowed to carry tobacco or matches under penalty of immediate discharge and are searched occasionally without advance notice.

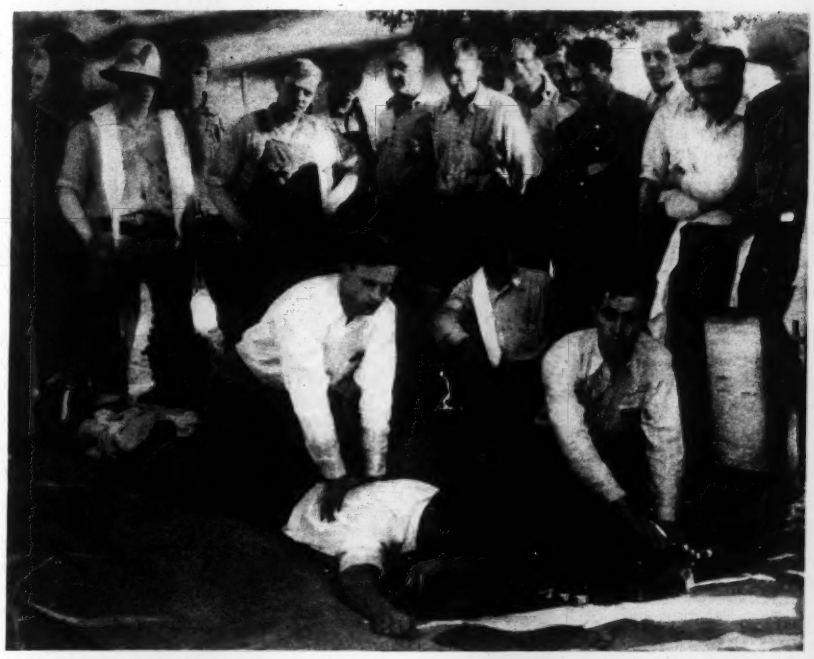
Two mine-rescue crews of six men each are trained and maintained at each camp during driving operations.

Testing for gas and rescue work

A further requirement of present operations is a fire boss on duty con-

Details of driving method that uses a pneumatically placed sublining immediately at the face after excavation, without the use of any timbering. If heavy shooting is required, a temporary timber set is used to keep the sublining one round behind the face.





First-aid training was given to 788 men during a one-year period, and competitions were held between various teams.

tinually in every face where driving is in progress. This man is equipped with an electric detector for determining the presence and amount of gas and makes tests along the line of the tunnel from the face to the shaft. Special precaution is taken at those points where gas is known to have occurred and also at the face. A special test is required immediately before the shot is fired, and the crew does not return until the fire boss has tested after the shot. The explosives are of the permisible type and are taken to the face in a special car which is locked and the key of which is retained by the fire boss. The fire boss operates the special permissible firing switch, which is locked except while in use. All men withdraw to a point 5,000 ft. from the face at the time of shooting.

An extensive program of first aid and rescue training is carried on. From June, 1931, to June, 1932, 788 men were given a first-aid course of two hours per day for a five-day period on their own time, and, if qualified upon completion, they receive the usual certificate of recognition. A competition between camp teams resulted in sending the first-aid team from Mocho Camp to the state first-aid meet where they won first in the mining division and third place in the meet. Considering the relatively temporary type of employment from which these men are recruited, this showing is considered particularly creditable.

Two mine-rescue crews consisting of six men each are trained and maintained at each camp during driving operations. These men are picked from experienced underground men such as shift bosses, miners, electricians, motormen, etc. Their training includes use of the oxygen mask and procedure for rescue work in case of an explosion or fire. Men taking rescue work are paid at the rate of 75c. per hour. A certificate covering mine-rescue training is given by the Bureau of Mines to each man completing this course.

A course in advance rescue work has been given to engineers and fire bosses by the Bureau of Mines. During the same period 542 men were given instruction in mine-rescue work. The orders of the California Industrial Accident Commission require that rescue crews be given additional training once a month and have a physical examination every six months.

Sublining replaces timbering

As soon as driving operations started from the deep shafts—in fact, during the sinking of some of the shafts—ground was encountered that proved extremely hard to hold, moving and squeezing slowly. This action occurred where the material was relatively soft and apparently resulted partly from air slaking and change in temperature. To resist it, the timber lining, which was originally in sets 8x8 in., spaced 5 ft., was increased in size until some 16x24-in. sets were in use. Difficulty with the moving ground continued, however, resulting in excessive maintenance and in replacing the timbering two and sometimes three times.

To effect some relief from this condition, a circular sublining of pneumatically sprayed concrete (Gunite) was tried where conditions were most severe. This type of lining, rather than one of regular poured concrete, was used because it permits a high-early strength. Also pneumatic spraying operations interfered least with driving, as the equipment is of small size. At first also attempts were made to use standard cement, but strength was not attained fast enough to take the load. Later a special quick-setting cement was used.

The first operations consisted of placing these sections of lining where they were most needed to eliminate excessive maintenance. Gradually these sections were closed up until long continuous sections were sublined. This procedure was described more in detail in *Engineering News-Record*, Jan. 15, 1931, p. 96.

Success in the use of the sublining and the savings effected in eliminating retimbering, re-excavation and in reducing track maintenance suggested the possibility of using this lining to eliminate timbering together. The method has now been worked out in detail and has been used with marked success for thousands of feet at several of the headings.

The driving operations are not changed. The schedule calls for a 6-ft. round, drilled with air-driven augers in soft ground or jackhammers with the occasional use of leyner drills if a stratum of hard rock is encountered. If the ground is particularly unstable, square bars of 1½-in. steel are placed ahead in the position of crown bars along the roof by drilling 2-in. holes 8½ ft. deep ahead of the face. By placing these bars in advance of shooting, the ground is supported while the crew is coming in from the shooting switch 1 mile back of the face. This roof support and breast boards ordinarily hold the ground during drilling, but temporary lagging is used when necessary.

After the round is fired the mucking machine loads the broken material, and then the invert is excavated by hand and trimmed as nearly as possible to the circular section, allowing for a 24-in. lining. Following this clean-up, steel circular guide rings of 1-in. reinforcing bars at 3-ft. spacing are placed in position. In the roof of the tunnel ⅜-in. bars are placed at 4-in. spacing longitudinally to support the wet concrete during setting. The steel is used as a shooting guide and to support the weight of the fresh sublining, and it is not designed to give strength in resisting pressure. The diameter of the hoops provides for a sublining 15 in. thick in average ground conditions and leaves a 9-in. space for the subsequent concrete lining. In very heavy ground the sublining may be increased in thickness and the excavation enlarged accordingly. A considerable amount of the sublining is 18 in., and some is 24 in. thick.

Two sublining outfits place the 6-ft. section. The work is begun at the bottom and is carried up simultaneously along both sides, building the mass up on radial planes.

Dry material, batched at the surface, is brought forward in four 2-cu.yd. car trains and is shoveled by hand. A rich

mixture is used, averaging eight to ten sacks of cement to the cubic yard of finished product. The fast-setting cement produces some strength within two hours and reaches the usual 28-day strength within 48 hours. The strength averages about 6,000 lb. per sq.in. Three per cent of calcium chloride by weight is added to the mixing water to accelerate set. The temperature rise for the 15-in. layer is approximately 30 deg.

When the condition of the ground requires not more than 1½ boxes of 40 per cent powder per round of 6 ft., the sublining is carried up to a point 1 ft. back of the face at each round. When more than 1½ boxes of powder is required, two or three temporary sets of timber are put in and then removed as the lining is applied and re-used to keep the forward end of the sublining 12 to 18 ft. behind the face. This lessens the shock of the explosion on the fresh material. Aside from this use of temporary timbering, the system eliminates completely all timbering for lining operations.

Operating cycle

Operations for the method of driving described are based on the completion of two cycles in 24 hours, although often not more than 20 hours are consumed. The crews are organized especially to carry forward all phases of the work without interruption. Thus, one shift takes up the work immediately where the last left off and goes through any of the required operations that may be required during that particular eight hours. Most of the crew members are required to perform at least two classes of work. The miners usually load the sublining machines when this process is in operation. The mucking-machine operators, because of mechanical training, double on operating the machines. Nozzlemen work as muckers during excavation. Other members of the crew often are sent back to track maintenance or pipe work when not required at the face.

The wage-scale arrangement provides that each man shall be paid at the rate represented by the work being done. Under ordinary conditions, however, no attempt is made to split the time, and each man is paid at the higher rate for the entire shift. The result increases the efficiency of the crew and makes for better organization. This is true except in cases where serious delay has changed the ordinary cycle. The average cycle is as follows: sublining, four hours; drilling, two hours; mucking, four hours; and spading invert and trimming, two hours.

The crew for this operation consists of one shifter, four miners, one chuck-tender, one mucker, two motormen, one mucking-machine operator, two nozzlemen and one gun operator. As driving advances, the track is carried forward and ballasted on the invert of the lined section. Ballast is required to help maintain the track for heavy hauling.

The Hetch Hetchy project is being carried out under the direction of the Public Utilities Commission of San Francisco, Edward G. Cahill, general manager. M. M. O'Shaughnessy is consulting engineer for the commission. L. T. McAfee is chief engineer and general manager, and L. W. Stock is chief designing engineer. The Coast Range tunnel work is under the direct supervision of C. R. Rankin, construction engineer, and Adolph Wehner is safety engineer. The California Industrial Accident Commission is represented by C. H. Fry, superintendent of safety, and Fred Lowell, mining engineer. S. H. Ash is safety engineer for the U. S. Bureau of Mines.

Water Sampler Avoids Contamination by Air Bubbles

By F. E. Daniels
Chief, Industrial Waste Section, Pennsylvania Department of Health, Harrisburg, Pa.

FOR THE rather specialized work of the Pennsylvania Sanitary Water Board in connection with stream surveys, the writer has designed and constructed a very simple, substantial and satisfactory apparatus for the collection of river-water samples for the dissolved oxygen, biochemical oxygen demand and alkalinity tests.

The apparatus is constructed wholly of brass and copper, collects four samples simultaneously directly in the test bottles, which avoids any transfer of water, is easily handled and presents a good appearance. It is rugged, to withstand rough usage and is sufficiently heavy to avoid the use of extra lead weight except perhaps for quick submergence in very rapidly flowing streams. In such a case a disk of lead may be placed in the bottom of the vessel.

The apparatus is constructed as follows: A disk of ⅛-in. sheet brass is fitted into one end of a solid-drawn brass tube 6 in. in diameter, 8 in. long and with a ⅛-in. wall. This forms a pail to which a brass bail is attached by ears securely riveted to the sides. A cast-brass lid is fitted to the open end and is held in place on a rubber gasket by two phosphor-bronze clips.

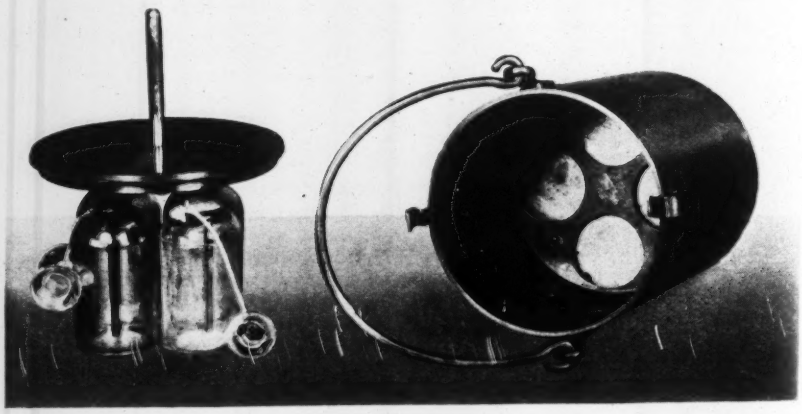
The lid carries four ⅜-in. copper tubes projecting downward into and nearly to the bottom of each of the four sample bottles, which are supported and held in place by a circular shelf at the proper distance down in the vessel so that the tops of the bottles are about ⅜ in. below the under side of the lid.

In the center of the lid is an air tube projecting upward with a ⅜-in. nozzle in its upper end, the lower end extending about 1 in. below the lid.

Four regular 135-c.c. test bottles are placed in the vessel on the shelf. The lid is then dropped on with a tube in each bottle and secured by the clips. A rope is attached to the bail with a halter snap, and the vessel is quickly lowered overboard to the desired depth. As the air escapes from the center tube, water flows through each of the four down tubes into the bottles, filling them to overflowing. This continues until the vessel is filled up to the lower end of the air tube. By that time the water in each bottle has been displaced at least three times.

When the air has ceased bubbling, indicating that the vessel is filled, the apparatus is raised and opened.

For use in very deep water the tubes may be plugged and the plugs withdrawn with a cord when the desired depth is reached. A valve on the air tube is not sufficient because of the number of water inlet tubes. If desired, a sterilized tube may be substituted each time for one of the inlet tubes to deliver into a sterilized bottle for a bacterial sample much in the same manner as described for the United States Public Health Service sampling apparatus.



The air originally in the sample bottle is displaced into the container by the entering water without causing bubbles at the mouths of the bottles. The air in the container escapes by a tube through the lid.

Strength of Aluminum Corrugated Sheet

Tests of alloy sheets reveal close agreement between computed and measured deflections and a large load-carrying capacity

INCREASING use of corrugated sheet of aluminum alloy led recently to a series of tests at the New Kensington, Pa., laboratory of the Aluminum Company of America to determine strength properties. The work was done by E. C. Hartmann, under direction of R. L. Templin, chief engineer of tests. The principal tests were made with normal corrugations (2½-in. pitch, ¾-in. depth), but a few were made on sheets with large corrugations (8¾-in. pitch, 2½-in. depth).

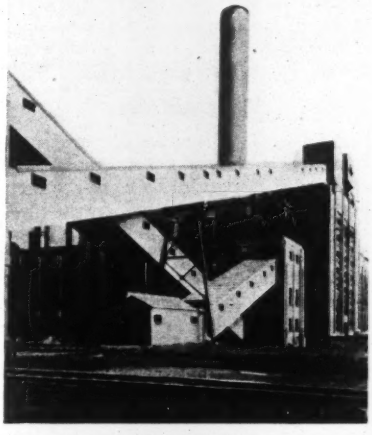


Fig. 1—Installation of aluminum corrugated sheet at Duquesne Light Co., Pittsburgh, Pa.

Material

Corrugated sheet for building purposes is manufactured from various aluminum alloys, the one most commonly used being the alloy 4S, in three-quarter-hard temper, with nominal tensile strength of 39,000 lb. per sq.in., yield strength of 35,000 and modulus of elasticity of 10,000,000 lb. per sq.in. Thicknesses range from B&S gage 22 (0.025 in.) to 14 (0.064 in.), and sheet sizes from 5- to 12-ft. length by 25½- to 40-in. width.

Careful measurement gives the following data on dimensional properties, expressed in terms of breadth b, thickness of sheet t and depth of corrugation d:

Developed width $k\,b = 1.2\,b$
Area of cross-section $A = 1.2\,bt$
Moment of inertia $I = \frac{1}{8}\,Ad^2 = 0.15\,btd^2$
Section modulus $S = \frac{1}{4}\,Ad = 0.3\,btd$
Radius of gyration $r = 0.354\,d$
Weight, lb. per sq.ft. $= 17\,t$.

From these data the safe uniform load, in lb. per sq.ft., for design stress f (this may be taken as 12,000 lb. per sq.in.) on span l, in inches, is $w = 346\,ftd/l^2$, and the mid-span deflection, in inches, under such load, at $f = 12{,}000$ lb. per sq.in., is $D = l^2/3{,}000$.

Test results

Of numerous sand-load tests, those of principal interest were made on panels 24x72 in. and in gages of 14, 16, 18, 20 and 22. The ends of the aluminum sheet were supported on wooden horses 6 ft. apart, and a rectangular sand-loading box was placed on top. Strips of cheesecloth were tacked around the inside edge of this box to prevent the sand from escaping as the sheet deflected. Dry sand was placed on the sheet in layers of uniform thickness, corresponding to load increments of 4 lb. per sq.ft., up to the point at which the load-deflection curve showed a considerable departure from the initial straight line. In the case of the thickest sheet the maximum load was 72 lb. per sq.ft., or 864 lb. total. For each load the retaining frame was lifted slightly from the sheet and shaken to prevent the sand load from being carried by the frame either through friction or through the cheesecloth.

None of the tests was carried to failure. Fig. 2, a typical load-deflection curve, shows the close agreement between measured and computed values, as well as the ability of the sheet to carry load far beyond the point of departure from a straight line.

Crushing tests of corrugated sheet against a 1½-in.-wide bearing strip placed crosswise of the corrugations indicated a wide margin of safety against end reactions of the magnitude likely to be encountered in actual design. For instance, a 16-gage (0.051-in.) sheet, restrained against lateral spread by a ¼-in. rivet at every third corrugation, supported a maximum load of 9,000 lb. per linear ft. of bearing strip. At a load of about 3,000 lb. per linear ft. of bearing strip the sheet showed the first signs of permanent set. These loads are far in excess of anything likely to be encountered in service.

SAFE LOADS FOR CORRUGATED ALUMINUM SHEET, TYPE 4S—½H. CORRUGATIONS ¼ IN. DEEP WITH 2.66-IN. PITCH

Computed for a Design Stress of 12,000 Lb. Per Sq. In.

Gage B & S	Thickness, In.	Safe Uniformly Distributed Load, Lb. Per Sq.Ft. 24-In. Span	30-In. Span	36-In. Span	42-In. Span	48-In. Span	54-In. Span	60-In. Span	66-In. Span	72-In. Span
14	.064	346	222	154	113	86	68	55	46	38
16	.051	276	177	123	90	69	55	44	36	31
18	.040	217	139	96	71	54	43	35	28	24
20	.032	173	111	77	56	43	34	28	23	19
22	.025	135	87	60	44	34	27	22	18	15

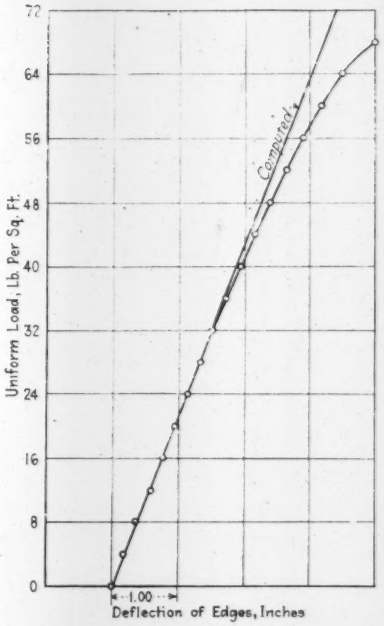


Fig. 2—Load-deflection curve of 16-gage corrugated aluminum-alloy sheet, with ¾-in. deep corrugations, tested with ends freely supported and with a sand load over an area of 24x72 in.

Oversize corrugations

The section elements given apply not only to standard corrugated sheet but to any geometrically similar corrugation. Strength and stiffness for the same weight increase with the size of corrugation, the strength increasing directly as the depth, and the stiffness as the square of the depth, providing a reasonable ratio of thickness of sheet to size of corrugation is maintained to keep the individual corrugations free from local weaknesses. A specially fabricated 16-gage sheet having corrugations 2½ in. deep and an 8¾-in. pitch held a load of 200 lb. per sq.ft. on a span of 8 ft. for sixteen hours with a permanent set of less than ½ in. The maximum measured stress in this sheet under this severe load was 38,000 lb. per sq.in., which is only slightly larger than the corresponding computed value.

While these larger corrugations are not being produced commercially today in aluminum alloy, they have given considerable promise in the preliminary tests, and they should not be overlooked in any design requiring unusual strength and stiffness.

Old Steel Road Bridges Restored by Welding

Reconstruction of steel-truss bridges to provide strength and roadway width for modern fast automobile and heavy motor-truck traffic as practiced by the Michigan state highway department

ADVANCES in welding have given a new economic position to old steel highway bridges built for traffic demanding much less room and strength and developing much smaller impact forces. Combined with concrete giving the ability to mold new forms onto the old, this recent tool of the bridge builder has created real values in thousands of structures that had been held usable only until money was available to replace them. A technique of renovation has been developed varying in detail in different states but always the same in its ability to salvage an investment that had been counted lost. Three articles follow which describe this technique in as many states. In the article immediately following is described practice developed in Michigan. The original account was given by the author to the Conference on Highway Engineering held at the University of Michigan in February, 1933. —EDITOR.

By C. A. Melick
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RECONSTRUCTION problems as they are presented by steel-truss road bridges can be best considered by starting with the roadway wearing surface and following in order with the structural or load-carrying part of the floor: (1) the structural system constituting the floor supports, which include cross-ties, stringers and floor beams; (2) the structural members receiving the load from the floor system and carrying it to the substructure, which include compression and tension truss members, laterals, bracing, shoes, joint details and main girders; and (3) the substructure itself, which includes foundations, neat or body portions of piers and abutments, bridge seats and back walls.

Stringers and floor beams

When the floor is of adequate strength and in good condition, some method of increasing stringer capacity is desirable which will not necessitate taking up a perfectly good floor. This can nearly always be accomplished by placing at mid-panel points an additional transverse floor beam immediately under the old stringers and framing this floor beam into longitudinal stringers just inside of the trusses such a distance as will permit framing them into the regular floor beams with top flanges flush with the tops of the old floor beams and with end-connection angles just clearing the hangers suspending the floor beams from the trusses. This detail usually works out as well for riveted floor-beam connections as for the more common cases where the floor beams are suspended from the truss pins above by U-hangers.

While grossly inadequate floors and grossly inadequate stringers are very common, inadequate floor beams are relatively rare. This is due to the fact that but few of these old bridges are wider than 16 ft. inside of trusses and therefore do not permit two heavy trucks to pass.

If the floor beams are inadequate, they may be strengthened by increasing the flange section by welding plates to the top and bottom flanges, or the light beams may be replaced with new and heavier beams. This latter operation should probably always be used whenever the first method requires taking up a floor that otherwise would have been left in place.

The most satisfactory method of welding flange plates to floor beams requires welding from above on flat horizontal surfaces. The top flange plates, therefore, should usually be ½ in. narrower than the beam flange, and the bottom plates ½ in. wider than the beam flange, this in turn requiring that the top plates be thicker than the bottom plates. Also, while strength does not require that the plates extend the entire length of the floor beam, the top plate must extend beyond the outside stringers to provide a uniform elevation for stringer rests. Welded work does not permit drawing the parts to be welded as tightly together as is possible with riveted work, and it is therefore highly desirable on exposed work that welds be continuous so as completely to prevent entrance of moisture and air between the plates and the beam flange.

Whether a ¼- or a ⅜-in. bead weld should be used will depend on the size of the plate, but a ¼-in. bead will quite generally be adequate. It is well to emphasize the importance of tack-welding these plates to the floor-beam flanges before undertaking any continuous bead. The tack welds will ordinarily be about 2 or 2½ in. long and should be spaced 12 to 18 in. apart. Only covered welding rod should be used to insure the least development of heat in the parts welded. Welding equipment should be at least 300-amp. capacity. No preheating of plates or shapes should be permitted on welded work.

Replacing a floor consists of placing a support under the stringers each side of the floor beam to be removed and bolting these supports temporarily to the bottom chord of the trusses each side of the pin or panel point. The old floor beam is then held in place by a cable at each end while the U-bolt hangers are removed; or in case of a riveted connection, the old rivets are busted out. The old floor beam is now lowered from place, and the new floor beam is placed, in the reverse order of procedure. The U-hangers may or may not need to be replaced with heavier or longer hangers. Usually the wider flanges or greater depth of the new beams will require new hangers, in which case they should also have an excess of area over the old of at least 50 per cent. Pin packings will readily permit this increased area. Where riveted connections exist, it may be desirable to ream out all old holes in the truss posts to permit the use of ⅛-in. larger rivets for increased safety. In this case it will quite generally be desirable to use threadlock bolts to avoid the probability of getting a very unsatisfactory job of field-riveting.

Floor surfaces

Aside from the minimum and most economical methods of bringing a floor system of a bridge up to legal strength, the desire exists to secure (in addition to strength, durability and smoothness) a finished appearance and freedom from continual maintenance. This usually means an additional wearing surface, a heavier floor type or a more expensive design. Improved appearance, smoothness and a wearing-surface of generally five to ten years' durability may be secured by adding an asphalt-plank wearing surface at an increased weight of 10 to 15 lb. per sq.ft. of roadway and an increased cost of 15 to 20c. per sq.ft. This must not be considered as having any load-distributing qualities, and experience indicates that the life may be very much less than five years, depending on the plank itself and on the nature of the supports. Appearance, smoothness and durability may also be secured by using a simple concrete slab floor with a weight of 75 to 110 lb. per sq.ft., but with a cost of not more than about two-thirds of that of any other type of smooth semi-durable floor. Also, a lug-surfaced steel-plate floor of welded battledeck construction can be used, with a total weight of about 25 lb. per sq.ft., but at a cost of about 50 per cent more than the simple concrete slab. There are also several other light-weight floor types of about the same cost that are worthy of consideration.

Truss compression members

Compression members of trusses are most easily repaired or straightened. Most compression members consist of two channels or two channels and a coverplate. All stress is transmitted at panel points through the webs. The most efficient and simple strengthening consists of a plate bead-welded its full

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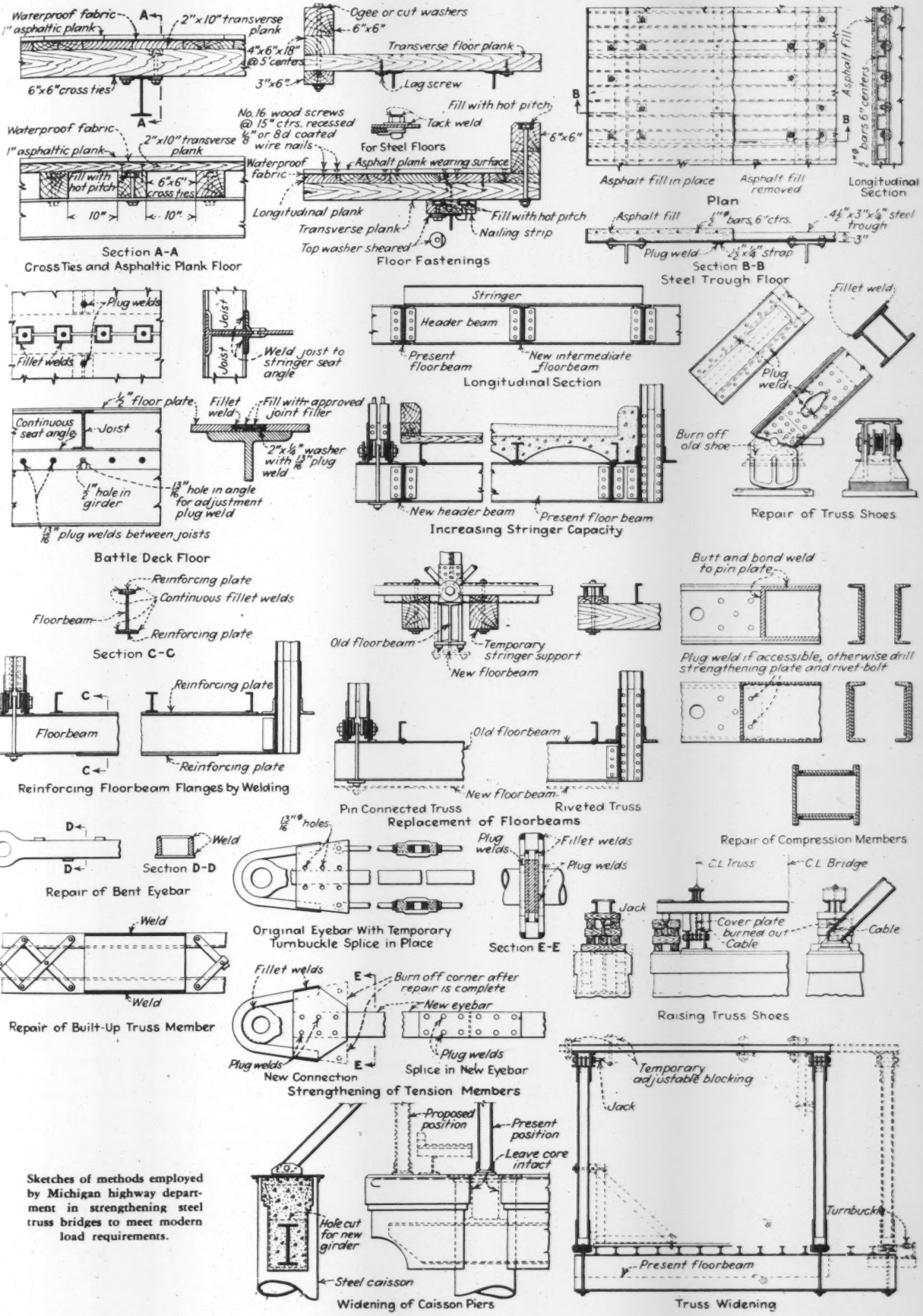


Sketches of methods employed by Michigan highway department in strengthening steel truss bridges to meet modern load requirements.

length inside the flange fillets to form a neat flat surface excluding moisture. The plate should fit within ¼ to ⅜ in. of the flange, so as not to require an excessively heavy bead and thereby add to the welding cost, and at the same time one not so small as to induce arcing across when the welding stick cannot be inserted into the very bottom of the gap. The ends of the plates should also be sealed from moisture by welding. If the strengthening plates extend to or a short distance beyond the pin plates (or gusset plates in case of riveted construction), this will usually be adequate. When such plates would be interfered with by rivet heads, the rivets should, when practicable, be busted out and, after placing the splice plates, plug welds should replace the rivets.

If the channel legs face in so as to make the fillets inaccessible for welding, the reinforcing plates should be placed on the backs of the channels and should be ½ in. narrower than the channel to provide room for a ¼-in. bead. If the hole from a busted-out rivet is on the inaccessible side of the splice plate, the splice plate should be drilled to match, and a short rivet head and shank should be inserted from the far side so that the rivet shank just about reaches the far side of the splice plates, and, while driven or held tightly in place, the hole in the splice plate should be plug-welded. Where lacing bars and channel flanges have been badly bent, it is desirable to remove the bars and bead-weld a plate in their place, using a plate not shorter than 1½ times its width.

Webs of end-post channels are often completely rusted through near the roadway level, which is very close to the end shoes and is difficult of access for welding on account of coverplates, pin plates and roadway floor. If the flanges are still in good condition and the corrosion does not extend too close to the pin, this condition is not serious, as there is usually considerable excess area at these points. However, if this corrosion extends close to the pin, failure may result by the pin shearing through the rusted web. Under such conditions the shoes will also likely be found in bad shape and the channel flanges none too good.

Repairing end shoes

The proper solution in this case is to have a new shoe made, either identical with the old or with better expansion provisions than were generally found on old bridges. The webs and pin holes should be of the same size and spacing except that web thicknesses should be increased somewhat for future corrosion protection. The new shoe web should also be finished without the hinge-plate finish, being sheared on a line ¼ in. below a diametrical line through the pin. When the truss is raised and suspended by cables around the end pin, the old shoe is burned off as near the pin as practicable, and the remaining plate around the pin is shoved aside. Then the truss is lowered onto the new shoe and a hinge collar is set in place over the pin and plug or fillet-welded to the web of the new shoe, depending on whether the shoe web fits inside or outside the end post web.

Without disturbing the bottom end-post lacing, burn out the entire lower part of the coverplate flush with the backs of the channels and to a height well above the corroded channel webs and slip in place the two short sections of splice channels after first drilling the old channel webs for plug welds; when in place and clamped tightly with pin bearings in contact, proceed to plug-weld. Remove the cables suspending the shoe pins and place the cover splice plates, welding to the old coverplate by means of both plug and edge fillets. A hinge jaw plate should now be plug-welded to the end post webs if the condition of the old channels is such as not to be adequate for this service.

Truss tension members

Tension members and counters, consisting of eyebars and loop bars, either adjustable or of fixed length, require special consideration. If these are buckled and bent, they should be straightened and brought back to take a dead-load tension roughly in accord with their design dead loads. The most common case of this is the buckled bottom chord resulting from abutments crowding streamward an amount in excess of the truss expansion provided for. Here the abutment shoes must first be freed and arranged to slide easily, then the chord bars straightened, and the truss action will do the rest. It is suggested that, in such cases, stiffeners be welded between eyebars at such spacings as may seem wise so as to enable the bottom chord to furnish greater resistance to abutment thrust in case the abutment continues to move. These stiffeners consist of staggered flats bead-welded to top and bottom edges of eyebars.

A very common mistake in strengthening eyebar members is to weld a flat on each side of the eyebar, extending as close as possible to the end pins. This is on the assumption that the apparently larger net areas at pins provide an excess of strength. This is obviously wrong, as the excess area in the head of the eyebar is needed to offset the stresses in transmitting the load from the bar to the pin. A plan is suggested for either the strengthening or repair of such members. U-shaped loop bars are actually bent to the diameter of the head of the eyebars and, after being treated for fit and placed in position, are then bead-welded to two splice plates on the open ends of the U. Two temporary loop rods connecting the splice plates at each pin are then placed, and an initial tension, approximating dead-load stresses, is applied, and the effect on other tension members on the panel is carefully observed. The original tension bars are then burned off close to the pin and at mid-panel and removed. The new and larger bar is then inserted in two segments in each direction from mid-panel and plug-welded to the splice plates by means of large-diameter plug holes in the end splice plates. With the ends of the new bars butting at mid-panel, connecting splice plates are now similarly plug-welded. Completion of this operation permits the adjustable loop bars to be removed.

When repairs requiring the raising or supporting of a truss are required, it will be simplest, of course, to jack up the end floor beams, if there are any, and if they are or can be connected to the trusses adequately to take the load. Unfortunately, few of these old bridges have end floor beams. Probably the simplest means of raising the bridge is then to burn out the lower part of the end post coverplates as already described and to pass cables or U-bolts around the shoe pin and attach to a bearing plate between two short longitudinal beams which, in turn, would rest on jacks supported on transverse beams supported on cribbing on the bridge seat outside the truss shoes.

Widening between trusses

In case it is desired to widen an floor beams should then be replaced with the longer new floor beams in the existing truss bridge, the bridge should first be rolled over until one truss comes to its final position. The old manner already described. The new transverse lateral struts designed to be supported upon the top of the top chords, with the new laterals attached to them in place, may then be placed and permanently fastened to the top chord of the truss to be moved over. Meanwhile, the new bottom laterals attached to the new floor beams will also have been put in place. Tension rods with turnbuckles may be attached now to the ends of all new floor beams with the other ends connected to the trusses at the panel points. Blocks, bolted to the bottom side of the top lateral struts each side of the coverplate of the top chord of the truss to stay in position, may be adjusted in stages to permit 3-in. shifts at each panel point by tightening up on turnbuckles and/or by jacking, and all panel points may be moved uniformly in 3-in. jumps until the new position of the truss is reached, when the floor-beam connections to the movable truss may be carefully adjusted and tightened and the top lateral struts at the fixed truss may be permanently connected. The new portal and sway-bracing may now be placed and new stringers set. This procedure is inexpensive and, in addition, requires no falsework.

Low-Cost I-Beam Bridges for Pennsylvania Highways

All-welded structures replace hundreds of weak bridges inherited from counties—Original temporary design evolves into permanent type

THE PRACTICE developed in Pennsylvania in modernizing its old road bridges has been replacement instead of repairs and reinforcement. Most of the bridges were on secondary roads that had been legislated into the state system and were antiquated in design and materials. Experience in renovation disclosed that at not much greater cost, and using a design of welding rolled shapes, replacement was possible. The design adopted is notable for its extensive use of welding and for its solid flooring of wood panels surfaced with a bituminous mastic. —EDITOR.

ALL-WELDED steel bridges are being built at very low cost in Pennsylvania in the program of the state highway department for replacing 2,000 county bridges taken into the 13,400 miles of state highway roads (as of 1929). A program to expend $27,000,000 in ten years in modernizing these bridges was laid out by the department. A survey showed that 955 of the bridges were unsafe for 13-ton trucks, which is the maximum size licensed by the state.

Most of the unsafe bridges were old timber structures, and some were of the covered type, as shown by Fig 1; of the remainder, steel trusses predominated, but there were a few masonry arches. Reconstruction was obviously an immediate necessity.

The immediate replacement of nearly a thousand bridges with permanent structures was financially and physically impossible. The highway department adopted instead a temporary replacement and strengthening program to be carried out by department forces. The program was started early in 1932, and in that year 467 bridges were replaced or strengthened by state forces. The year's work included: 303 I-beam structures of a total span length of 14,755 ft., built at a cost of $983,000, and 81 trusses repaired at a cost of $244,000; 18 reinforced-concrete bridges, totaling 460 ft. clear span, built at a cost of $76,245; and 75 short-span timber bridges, totaling 588 ft. of clear span, constructed at a cost of $36,700.

Design and construction

All of the new bridges were built 22 ft. wide between curbs. The idea at first was to get the old bridges replaced as cheaply and as quickly as possible, and the original designs called for utilization of as much as possible of the old foundations. Wherever necessary, timber bents were to be set up between existing piers and abutments. The general design was for I-beam longitudinal stringers topped with laminated wood flooring and a bituminous wearing surface, with wood curbs and guard-rails. It was soon found that a much better bridge could be built at slightly additional cost.

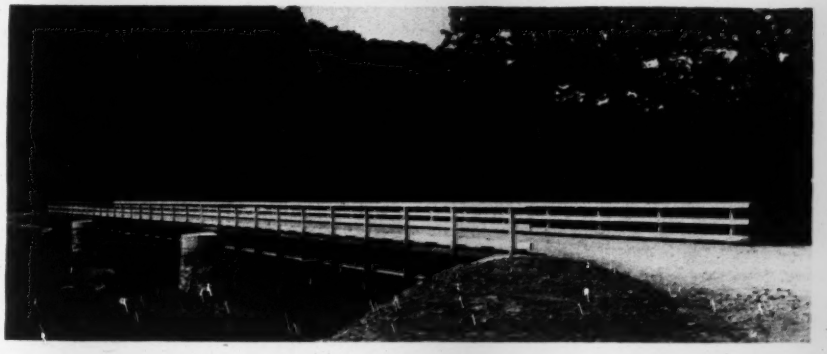
The first improvement in design was the addition of steel guard-rails. It was also realized that a little more care and expense on foundation work would change the temporary structures into practically permanent types. Therefore, the timber bents were dispensed with; and where it was necessary to provide additional piers or abutments they were built of stone masonry or concrete. Fig. 1 shows the modern structure and the covered bridge that was replaced.

The current design, subject to improvement at any time, is an all-welded I-beam structure with steel curbs and guard-rails. The design is shown in detail by Fig. 2. While the size and spacing of the longitudinal stringers varies according to span length, on all spans over 18 ft. the beams are rigidly held in place by welded angle cross-bracing. The guard-rails and their supports, it will be noted, are of rather ingenious design.

Each guard-rail post consists of two $6\frac{1}{2}$x$3\frac{1}{2}$x$\frac{3}{8}$-in. angles supported by 4-in. bars inserted through slots burned in the webs of the outside two stringers, just below the top flanges. On the inside of the inner of the two stringers these bars are keyed by short sections of angles or bars. The bars extend far enough outside the outside stringer to catch the railing posts. The bottom support of the posts consists of a 3x3-in. angle welded to the bottom flanges of the outside two stringers and extending out far enough to catch the post. The posts are welded to both the supporting bar and the supporting angle. Where the stringers are less than 18 in. in height, the supporting bars and angles extend through the outside three stringers.

Just above the roadway level a plate bracket is welded to each pair of angle posts. These brackets carry continuous 6x6-in. angle hub guards. About 2 ft. above the floor level and welded to the posts are supports carrying a 12-in. 12-

Fig. 1—Old county road bridge at left, which was replaced by the welded I-beam structure shown below.



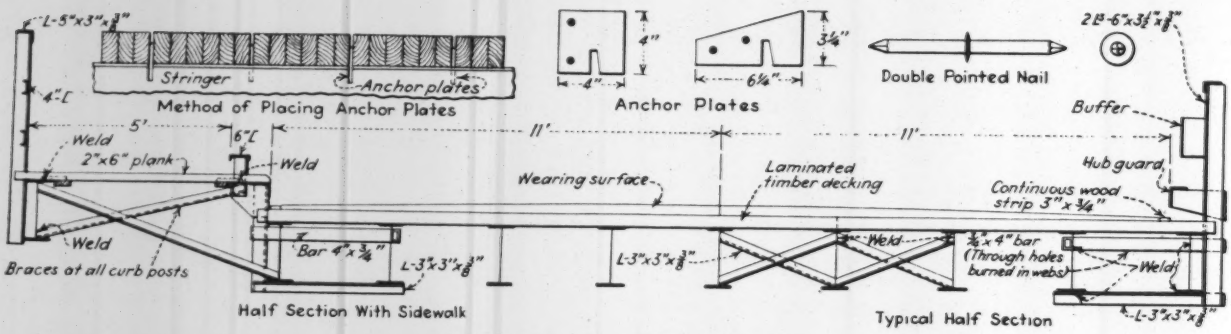


Fig. 2—Cross-section and floor details of welded I-beam bridge with steel hand-rails, which is being built in old-bridge replacement program of Pennsylvania highway department.

gage resilient steel buffer. The guard-rail posts are capped with a continuous 5x3-in. angle.

Wherever sidewalks are required, they are cantilevered out 5 ft. from the outside stringer. A longitudinal stringer is carried under the outside edge of the walk. The usual type of guard-rail is dispensed with along the roadway edge next to the sidewalk. Instead, there is a double curbing, consisting of a continuous angle set 8 in. above the edge of the roadway and a channel carried on short posts set 6 in. above and 6 in. back of the first curb. The sidewalk railing consists of T-posts welded to the outside of the sidewalk stringer, two longitudinal channels and a continuous 5x3-in. angle top rail. All sidewalk connections are welded.

The roadway decking consists of laminated 2x4-in. or 2x6-in. timbers set parallel with the abutment lines. The timbers are fastened together in panels of twelve, and in each panel are set two anchor plates that hook around the top flanges of the stringers (see detail in Fig. 2). The top of the timber deck is swabbed with hot tar or asphalt before the wearing surface is placed. The wearing surface is a cold-mix asphalt 1 in. thick at the edges and 1¾ in. thick at the center of the roadway. The edges of the wearing surface are held in place by continuous 3x¾-in. wood strips. The sidewalk deck consists of 2x6-in. planks laid flat with ½-in. open joints.

Bridge-building organization

The state highway department is divided into six divisions, each under the direction of a division engineer. Every division is divided into two districts, each having a district engineer. Some of the districts have extensive engineering organizations, including a bridge engineer. Directly under the district engineer are county superintendents, each in charge of an entire county. The district engineers make up the budget, covering work to be done. After funds are allocated, the district engineers make up a material list to cover all requirements. All materials are purchased by the state purchasing department.

The actual construction of these low-cost bridges is left to the county superintendents. The state highway department has prepared standard designs and has also prepared a complete table of materials for every span length from 2 to 76 ft., from which the superintendents can make up a list of materials for each structure. The size of stringers varies from 6-in., 12.5-lb. to 36-in., 150-lb. beams, depending upon span length. Most of the steel up to 12-ft. span length is supplied from salvaged stock.

About the only erecting equipment required is a portable welding outfit. In almost every case the beams can be rolled into place without the use of derricks, but A-frame derricks are available if required. Last year the bridge improvement program was tied in with unemployment relief. In the selection of men required for bridge work the county superintendents usually found an ample supply of experienced men. Experienced stone masons, painters and welders were available. After erection, all exposed steelwork was given three coats of paint in addition to the shop coat.

This program of low-cost bridge construction is being carried out under the direction of S. S. Lewis, secretary of highways, and Samuel Eckels, chief engineer of the department.

Widening Highway Bridge Decks in Mississippi

By constructing new and wider slab on top of old slab of concrete deck structures, economy and speed are attained—Steel spans widened by substituting deck girders for pony trusses

ABILITY to mold concrete to old bridge deck was taken advantage of in Mississippi in widening a bridge with concrete trestle approaches and a steel-truss channel span. While the operation was one of widening a comparatively modern type of structure rather than replacing or renovating an obsolete structure, the procedure has applicability in replacing old steel and concrete bridges that require more roadway room for modern traffic volumes and speeds. —EDITOR.

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SEVERAL concrete bridges on state highway routes in Mississippi have been widened by a procedure that has proved very satisfactory both from an economy and construction speed standpoint. The procedure consists of placing new concrete slabs on top of the existing slabs, the new slab overhanging the old construction on either side.

Illustrative of the method was the recent widening of a bridge over Okatibbee Creek south of Meridian, Miss. This bridge as originally built consisted of an 80-ft. steel-truss span with concrete-slab deck spanning between floor beams, and 226 lin.ft. of concrete beam spans, all on concrete substructure. When constructed in 1923, an 18-ft. roadway was provided, but increases in traffic since that time made a 23-ft. roadway advisable. Widening the concrete beam spans was accomplished by removing the concrete curbs, railings and the asphalt wearing surface. A 7-in. reinforced-concrete slab was then placed on top of the existing deck, overhanging it a sufficient distance on both sides to provide a 23-ft. roadway between the new curbs and 24 ft. 4 in. between the new railings. Since the new curb is of an open design and since pipe rails were substituted for the original concrete railing, very little dead weight was added to the spans by the reconstruction. Also, the spans as originally designed allowed for the weight of 6 in. of compacted gravel, which will not be utilized in the reconstructed bridge.

In widening the 80-ft. steel-truss

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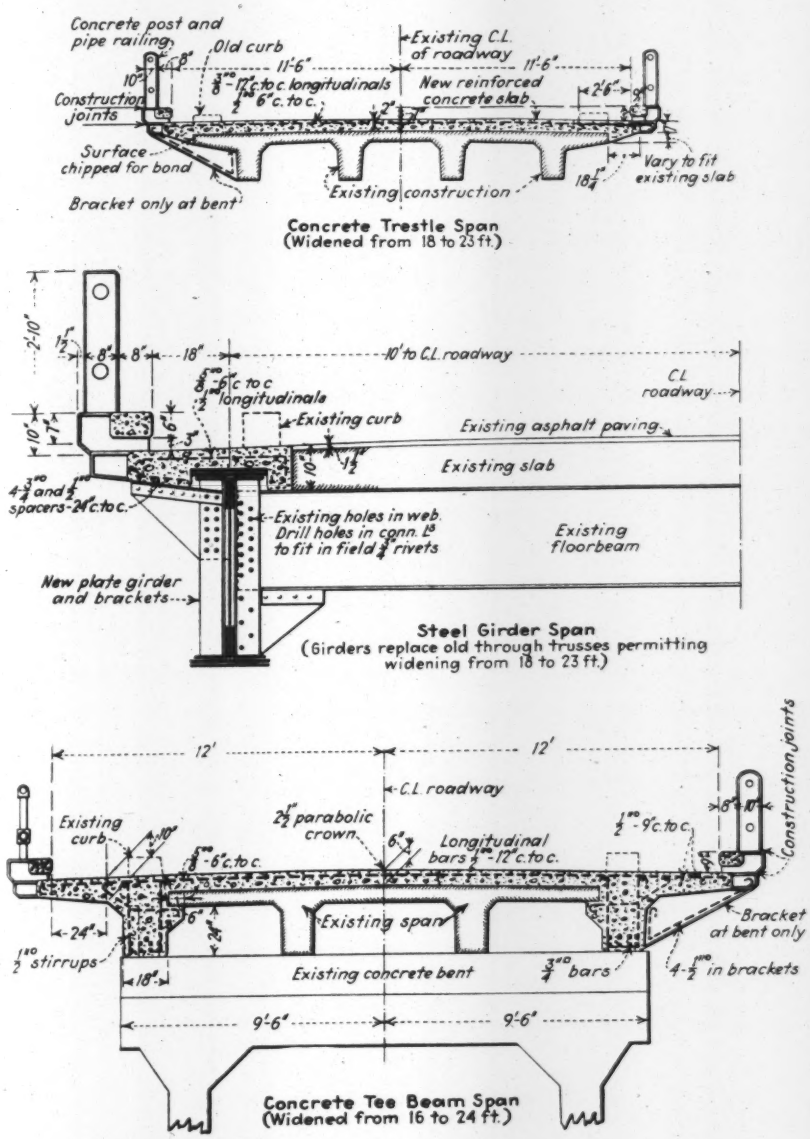
span, deck-plate girders were substituted for the pony trusses. In carrying out this work falsework bents were set under each floor beam and the concrete slab was cut away from the floor-beam connections. One truss was then dismantled, removed and replaced by a new plate girder, the webs of the two center floor beams being connected to the stiffener angles of the plate girder through holes punched in the field to match the floor-beam connections. The opposite truss was then replaced by a girder in a similar manner, and as the floor beams were lowered, starting at the center and working toward each pier, they were riveted to the stiffener angles, so that the finished grade line was on a parabolic curve 1½ in. higher at the center of the span than the new grade of the concrete approach span at each pier. As a final operation, the concrete slab was widened on each side to provide the 23-ft. roadway, and curbs and railings were constructed. Under this method of widening, the original concrete deck slab and steel floor beams can be left in place, and no changes need be made in the substructure of the bridge.



Widening concrete bridges by building the new slab directly on the old is a new practice of the Mississippi highway department. A section through a widened steel span is also shown.

Contractor and costs

The work on this bridge was done within a reasonable length of time and with considerable economy. J. A. & H. E. Pigford was the contractor, and J. B. Craig was resident engineer for the state highway department. The unit contract prices were as follows: concrete, $18 per cu.yd.; reinforcing steel, $0.03 per lb.; railing, $1.30 per lin.ft.; and structural steel, $0.0395 per lb.

At the present time work is under way on two old concrete tee-beam bridges between the towns of Magnolia and McComb. Here the roadway is being widened from 16 to 24 ft. The design is shown in the accompanying drawing, where it will be noted that, in addition to the new concrete slab over the top of the old slab, there are also added new facia beams on either side. On this work unit prices were: concrete, $13.40 per cu.yd.; reinforcing steel, $0.03 per lb.; and railing, $1 per lin.ft.

Runoff and Erosion Studied in Tests in California

TO PROVIDE for large-scale field tests on the effect of vegetation cover on the runoff and erosion of watershed areas, three dams and lined reservoirs are being built in the Angeles National Forest, Calif. Funds have been appropriated under the Emergency Improvement Act, and it is planned to complete the work with men from the Conservation Corps, both provisions offering unemployment relief in accordance with the program of President Roosevelt.

The reservoirs will be of 10,000-cu.ft. capacity each and will be concrete-lined. They will be formed by the construction of three slab-and-buttress type dams about 15 ft. high and 30 ft. long. Immediately above each reservoir will be installed measuring flumes and weirs to determine the flow. Located on Bell Canyon, on the Big Dalton Canyon in the San Gabriel mountains, the tributary watershed areas are 6,580 and 104 acres, respectively.

The program of study includes obtaining data from each of the watershed areas in their natural condition for a five-year period, as basic information. Then, one of the areas will be burned and maintained in a barren state, another will be burned and allowed to return to its natural condition, and the third will be kept with its present cover as a control.

Flumes will be used to measure streamflow from 3 to 50 sec.-ft., and the arrangement provides that flows of less than 3 sec.-ft. can be measured with the V-notch weir. The flow-measuring devices are all equipped with recording gages.

The silt washed down by the streams will be measured in the concrete-lined reservoirs.

The experimental features of the work are under the direct charge of W. C. Lowdermilk under the supervision of E. I. Kotok, director of the California forest experiment station. Design and construction of the dams and reservoirs is being done under the supervision of E. W. Kramer, regional engineer of the California region of the U. S. Forest Service.

Federal Engineering—Article V

Irrigation Work in the Indian Bureau

On Indian reservations in the West there are a number of reclamation projects operated by the Bureau of Indian Affairs for the purpose of helping the Indian to become self-supporting

WITHIN a radius of 600 miles of Salt Lake City there are 26 Indian irrigation projects functioning through the Bureau of Indian Affairs of the Department of the Interior. Some are easily accessible, but many are in the heart of Indian reservations several miles away from railroad or common routes of travel.

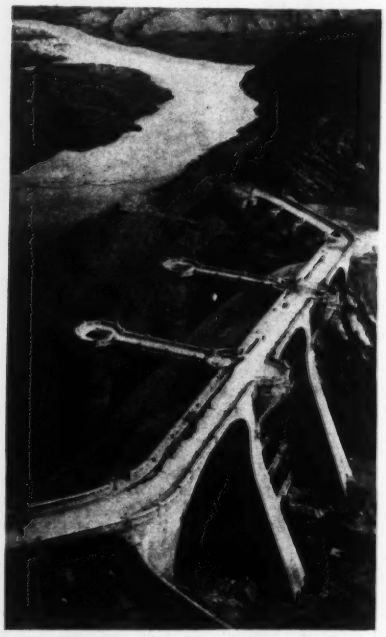
The Bureau of Indian Affairs was organized when early legislation gave the Secretary of War responsibility for relations with the Indians. The responsibility was afterwards transferred to the Secretary of the Interior. In its long history the bureau has suffered fraud and mismanagement and in addition has been exploited as a cover for ulterior purposes. This was one of the phases of the development of the West and ran true to form with land frauds, fraudulent surveys and railway land grants. Indians were successively moved from Florida, Mississippi and Illinois by the pressure of Western immigration, and in the course of time were re-established, sometimes in a niggardly manner and sometimes in the most generous way on new lands in the West. Courts and equitable administration have subsequently stabilized the theory of Indian reservations, and the United States, through its Secretary of the Interior, is now a guardian in trust for millions of acres of land in the West. Little by little, under certain restrictions, the Secretary has allotted lands having agricultural or grazing value to individual Indians, and is tending toward a policy of absorbing the Indian as a competent citizen and landowner without distinction from any other citizen. On the other hand, the federal law appears to require the welfare action of the United States whenever such a competent Indian becomes indigent. From the early haphazard and ill-considered treatment of the Indian there has emerged a bureau with trained welfare personnel competent in education, health and industrial and farming extension. This welfare function of the Indian Bureau is by far the most costly phase and the one most in the public eye.

The Indian irrigation service is fundamentally a business proposition whereby the government advances the capital required for irrigation works and the lands are charged with the prorata cost. It is in this sense closely to be compared with the similar practice of the United States Reclamation Service in the development of public lands. The difference lies principally in the welfare aspect, the purpose in this case being to induce the Indian to cultivate land and thereby become self-supporting.

Irrigation engineering within the Indian Bureau began in a small way as early as 1867, but no permanent personnel or specialists were assigned to it until about 1908, when Walter H. Graves was appointed superintendent of irrigation and developed the extensive ditches on the Crow Reservation in Montana. Gradually, when legislation arose providing for the advance of funds by Congress, to be reimbursed by Indian lands for irrigation purposes, a larger staff of irrigation engineers became necessary and was organized as the irrigation division of the bureau. The engineering personnel at present numbers 39.

The irrigation division brings the water to the boundary of the farm unit, or Indian allotment. The work of leveling, clearing and building farm laterals is left to the Indian owner, unless he elects to have it done for him on reimbursable loans. The areas developed have not been entirely subject to logical choice by the agricultural and engineering experts of the service, but in many cases have been forced by the pressure of legislation. The result has been an exploitation somewhat more rapid than the absorptive capacity of the Indian farmer. At the present time, however, this pressure has been largely removed, and the service is devoting itself to the completion of initiated projects. Only in one or two instances does it contemplate the initiation of new ones.

Today the major portion of the irrigation organization is devoted to the operation of 26 projects, covering 730,000 acres of irrigable land. It also has responsibility for maintenance and engineering advice on 84 minor projects operated by the Indians themselves or for them by superintendents of reservations or water associations. The 26 directly operated projects are fairly comparable to the 22 projects of the Reclamation Service and are managed by an analogous personnel with similar accounting and administrative functions. In a few instances it has been possible, through joint works, to combine the interests of an Indian development with that of adjoining white lands, and the Indian Irrigation Service is in some cases administering not only the furnishing of water for Indian lands but for white lands as well, and is making collections for operation and maintenance and construction charges from them.



The Coolidge Dam in southern Arizona was built by the Indian Bureau as part of the San Carlos irrigation project.

The United States has pursued a policy of extreme leniency with regard to the collection from the Indians for the reimbursable charges against their land. Under the law the operation and maintenance charges may be postponed by the Secretary of the Interior, and this has generally been done on all except three of the projects. A certain proportion, about one-third, of the original Indian irrigated land has passed from Indian title, for a competent Indian has a right to sell land that has been patented to him in fee. Transfers of title also arise from administrative sales of Indian land under guardianship, when a deceased owner has a large number of heirs and it is impracticable to subdivide the tract. Often it is found to be preferable to sell at public sale and distribute the proceeds among the numerous heirs. Out of the total 730,000 acres under constructed ditches, 431,000 acres are actually irrigated. Of this, the Indian, under trust guardianship or in fee, owns 60 per cent and whites own 40 per cent.

The reimbursable principle in Indian administration has been drastically modified by the so-called Leavitt Act, passed in the last session of Congress, which authorizes the Secretary of the Interior to adjust or eliminate reimbursable charges. Under this law the Indian Office, on Dec. 15, filed for cancellation a total of $3,115,469, existing as debt against individual Indians or tribes, and it is expected that about $6,000,000 more will be wiped off the books eventually. Included in the present total to be canceled is $870,000, representing the cost of roads and bridges from which, according to the Indian Office, the general public derives more direct benefit than do the Indians; $116,970 representing expenditures for tribal herds that proved to be experimental failures, and $2,128,146 reimbursable from individuals for maintenance and operating cost of irrigation. No attempt has ever been made to collect either construction or maintenance and operating costs from the Indians, except when it was evident that they were able to pay, and the total given above includes fourteen projects on which it has been evident that payment could not be made.

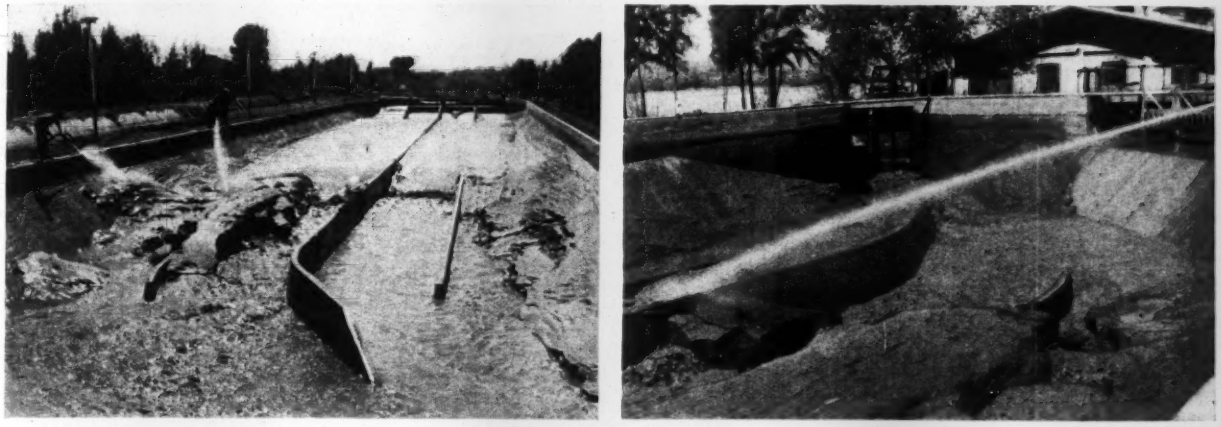
The law further provides that collection of all irrigation construction costs against Indian-owned lands be deferred until the Indian disposes of his property. This includes land patented to Indians who in other respects are subject to state taxation and occupy the same status as any white citizen.

A few of the irrigation projects maintained within federal reservations are described in the following:

The Wapato project

In the state of Washington, immediately adjoining the well-known Yakima project of the Reclamation Service, is the Wapato Indian Service project. It is notable as fulfilling all of the desirable features of an irrigation project, whether it be considered from the welfare standpoint or as purely a commercial enterprise. In a region where land values under normal conditions may reach $150, a project has been developed at a cost of $35 per acre. The water supply is ample for the irrigation of 139,000 acres, of which 85,000 are now under irrigation. The remainder consists of areas that require drainage. The annual operation and maintenance charge is $1.25 to $1.85 per acre. The management consists of a project engineer of the Indian Irrigation Service, a disbursing agent, assistant engineers, clerks and eighteen ditch-riders. About one-fifth of the lands have fully paid up and reimbursed the government charges, and there is no reason to suppose that the remainder will not be fully paid. The rate of payments was fixed on this project to extend over a period of twenty years.

The Indians are paying the same operation and maintenance charges as are white owners.



A silt trap has been built at the intake of the irrigation project at Parker, Ariz., to hold the silt carried in Colorado River water. These views show the silt-sluicing operation, during which water is carried around the basin by the concrete-lined canal seen behind the men at the left.

Silt problem on the San Carlos project

The San Carlos project in southern Arizona provides for the irrigation of 100,000 acres, one-half of which consists of white-owned lands. The principal feature is the Coolidge Dam, costing some $6,000,000 and impounding 1,000,000 acre-ft. The design of this dam is new and daring and comprises three dome-shaped arches. Its construction involved the relocation of the Southern Pacific Railroad for many miles to avoid the backwater of the reservoir. The construction cost per acre reached $100, justified by the extremely favorable climate of this portion of Arizona, where crops mature during ten months of the year. It is very favorable for the production of alfalfa but, wisely or unwisely, it has been principally devoted to cotton culture. The cost of operation is $2 per acre. The project management consists of a project engineer of the Indian Irrigation Service and some 25 employees. The project also operates a power plant, utilizing the fall of the water at the Coolidge Dam.

A stubborn problem in this project is the handling of silt carried by the Gila River into the project canals. This is due to the San Pedro, which is without storage, having 5,000 square miles of drainage area and carrying an enormous silt volume. The operative difficulty is realized when it is shown that the maximum daily deposit is 15,000 cu.yd. It is removed by special machines that straddle the canals and remove the silt without stopping the service of water. This is accomplished at 5c. per yard, so that at times the daily cost amounts to $750 for silt removal alone.

The solution is being attacked by the engineers of the Irrigation Service and may lie in wholesale debris being impounded in the upper San Pedro River, or in the erection at the intake of a silt trap similar to one successfully installed by the service on the Colorado River at the Indian project at Parker, Ariz.

An entirely different type of project is the purely Indian Hogback project near Shiprock, N. M. The lands in this case are tribal lands within the great Navajo Reservation, which covers altogether 15,000,000 acres of high plateau and arid country. On this reservation a number of tiny developments divert water from mountain streams to allow subsistence farming by the nomad Navajos, essentially a sheep-herding people. The Hogback project itself serves 8,000 acres, and irrigation from the San Juan River costs $3 per acre. It is an example of good project discipline. The project foreman, in addition to serving the water, has the duty of designating the tracts of land on which a Navajo applicant may farm. He also has the duty of canceling this permit in case a particular Indian does not farm. The result is that there is great activity in subsistence farming, and crops of alfalfa, corn and beans are raised in a highly efficient manner.

Minor projects

In addition to irrigation works of this nature, there are numerous small projects in which 100 acres or more have

been provided with ditches to supply allotted land. Here the efficiency is not notable, for the same conditions that make for inefficiency on private lands are in effect. Some are owned by aged Indians, others are in heirship status, and others are owned by Indians who prefer employment elsewhere and so neglect their farms.

To bring unused tracts into production, it is the right of the superintendent of a reservation, on request of the Indian, to arrange a lease to white persons, and to a considerable extent this practice exists. To this same extent the United States is being reimbursed for the operation and maintenance charges. However, these minor projects are least satisfactory from a welfare standpoint, for the economic compulsion to farm is slight, and the crops chosen and methods of tillage are often inadequate to secure results.

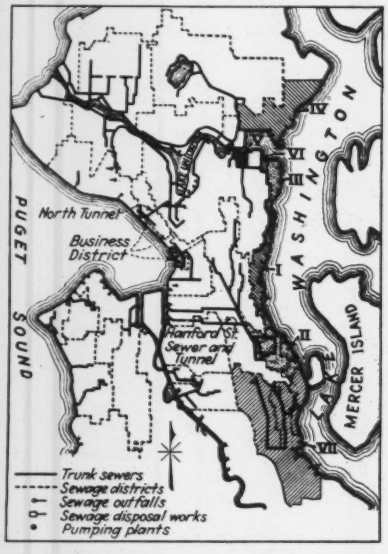
Reclamation does not always, in fact does not usually, involve the construction of dams costing millions of dollars; but frequently this is accomplished, for example, by digging water holes in dry streambeds which, when filled by freshets, become a permanent water supply for grazing lands. Often Indians do the job themselves with government assistance only as to materials and tools. Such works, small in themselves, frequently make available great areas of grazing range in the reservations by providing the watering places for stock with water holes, cased wells and windmills.

Freeing Lake Washington From Sewage

A PROJECT to eliminate the discharge of sewage into Lake Washington, which bounds the east side of Seattle, Wash., constitutes one of the most important programs in the sanitary field now under way in the Pacific Northwest. With three units completed, this development when finished will eliminate the disposal of sewage from numerous independent outfalls along the lake shore, which fronts high-class residential property and includes many bathing beaches. Ultimately the plan will serve an area of more than 4,000 acres, include fourteen pumping plants and cost about $5,000,000.

The City of Seattle extends north and south between the Puget Sound waterfront on the west and Lake Washington (fresh water) on the east. The area along the lake shore consists of residential property, and sewer service for this area was originally taken care of by the construction of numerous small outfall sewers into the lake. This development was gradual, so that before the city was financially able to consider a comprehensive plan and start the program now in progress there were 29 such outfalls serving the area, carrying both sanitary and stormwater sewage. Several years ago agitation toward providing treatment for this raw sewage resulted in the installation of Imhoff-tank plants, using chlorinated effluent on three outfalls. The remaining 26 discharge raw sewage. Increasing residential development on this area and the more extensive use of the bathing and recreational facilities of Lake Washington resulted in the present comprehensive program of interceptors and pumping plants to place this sewage into the other city trunk lines discharging westward into Puget Sound. This plan was adopted after considering a program of providing treatment plants with discharge of the effluent into the lake. The primary reason for rejection of the plan for disposal plants was the public objection to sewage-treatment plants in a residential district.

At a bond election in 1926, $2,125,000 was provided as a general city assessment, this amount to be matched by an equal sum assessed against the property benefited. The project provides intercepting and pumping facilities to equal 10 per cent of the total capacity of the outfalls intercepted. This capacity will take care of all sanitary sewage flow and 94 per cent of the stormwater. It is equivalent to handling 0.1 in. per hour of runoff on the sewered area. This would appear to be a small capacity to handle practically all stormwater flow, but rainfall intensities of the Seattle region are extremely low. As a result, the proposed pumping capacity will take care of the combined sewage except for extreme cases of stormwater flow, when the excess will be bypassed into the lake directly.



Interceptors and pumping plants along Lake Washington at Seattle divert flow from 29 small outfalls into Puget Sound.

For construction purposes the area was divided into seven units, and plans were made for developing each independently. Although each unit involves different problems, in general the design provides for an intercepting sewer near the lake front with from one to three pumping plants as required by the lift. The pumping lines discharge, in most cases, into trunk sewers flowing westward into Puget Sound. One exception to this general design provides for a disposal plant before discharge into Puget Sound because of the proximity of industrial areas, but detailed plans for this unit have not been prepared as it is the last step in the progressive development.

The total area to be served in the ultimate plan includes about 4,000 acres. The population on this area is at the present time about 17,000, but designs are based on twenty per acre as the ultimate figure. Pumping plants probably will total fourteen, although definite designs for some of the last units have not been prepared.

The initial unit completed in January, 1931, consisted of about 5 miles of vitrified-clay sewer, from 8 to 24 in. in diameter, and two pumping plants. This interceptor picks up the flow from eleven small outfalls serving 256 acres. The two plants have a combined capacity of 4,000 g.p.m. and a 125-hp. pumping installation. The cost of this project was $180,574. It was on this project that the precast asphaltic sewer joints described in *Engineering News-Record,* June 11, 1931, p. 976, were introduced so successfully under difficult wet trench conditions.

The second unit immediately south of the first was completed in November, 1931. It includes about 2 miles of sewer, intercepting four outfalls that serve an area of 584 acres and cost $175,365. This unit includes three pumping plants, with a total capacity of 11,000 g.p.m. and a 150-hp. installation. The Hanford St. trunk sewer was constructed at a cost of $1,240,000 as a part of this system, although not for the exclusive use of this latter pumping project.

The third unit immediately north of the first unit was completed in January, 1933, at a cost of $89,637. It includes about 1½ miles of sewer, intercepting two outfalls that serve an area of 142 acres. This unit includes two pumping plants, with a total capacity of 5,000 g.p.m. and a 105-hp. installation.

New Method of Blasting Swamp for Highway Fill

Alternate layers of mud and sand are cut through by blasting trench full width before depositing fill—New methods of placing explosives developed

By Charles L. Wooley
Construction Engineer, State Board of Public Roads, Providence, R. I.

THE CONSTRUCTION of Boyd's Lane, a state road in Portsmouth, R. I., called for a fill across a salt marsh that was some 1,100 ft. long and rose 6 ft. above the water line. This fill was to be 54 ft. wide on the top and was to carry a 24-ft. bituminous-macadam pavement with 15 ft. of gravel shoulder on each side. An examination of this marsh showed the surface to consist of small ponds of open water dotted with islands of heavy marsh grass from 1 to 2 ft. thick. Soundings taken upon the location showed unstable material from 10 to 15 ft. deep.

In most swamps previously sounded this total depth of unstable material has been uniformly soft. On this location, however, two or three sandy layers or lenses roughly 3 or 4 ft. apart vertically separated the unstable material. This was almost fluid, but the lenses had considerable supporting power. As the marsh has been subject to tidal flow, it is believed that the lenses were formed by a combination of the subsidence of marsh grass-root mats plus a deposit of sand from extremely high tides.

The task of insuring complete subsidence and settlement of the new fill through this material presented the difficult problems of liquefying and ejecting the extremely unstable mud and of destroying the supporting power of the sand lenses in order that they might not temporarily support the fill and subsequently fail with disastrous effect upon the road.

On previous fill-settlement jobs the plan of procedure had been to break up the top mat by charges of ditching dynamite placed some 2 ft. apart, 1 ft. under the water and fired by propagation. This system has usually removed and liquefied the top mat for a depth of some 2 to 4 ft. Then a continuation of this plan was to make the fill and blast the unstable material out from under it. It was concluded that this plan would not be successful as it did not appear that the sand lenses would be properly broken up and, further, that a removal of the top mat might disturb the conditions below the new fill and eliminate to a great extent the control of the underfill blasting.

An explosives expert connected with the DuPont Co. was called into consultation, and he suggested a plan that was adopted. This consisted in blowing a trench for the full depth of the muck and some 45 to 50 ft. wide along the line of the project. This was accomplished by placing three rows of shots, one on the center line and the others 20 ft. to the right and the left of the center line, as shown by Fig. 2. Ditching dynamite was used to aid propagation and save dynamite caps.

An interesting and novel plan of loading was developed. Galvanized pipes (1½ in.) were fitted with T's at one end, and pipe handles were attached to the sides of the T. Galvanized pipe of 1-in. diameter, with a ring at one end and a solid point at the other end, was used as a core bar, placed inside the sleeve described above. A detachable pin through the T tied the core bar and sleeve together. With this instrument, holes some 2 ft. apart were worked through the mud. The core bar, when removed, left the sleeve in place, and the dynamite was loaded through the sleeve. A 1¾-in. turned-oak tamping stick forced the dynamite into place. As the charges of dynamite were placed the sleeve was gradually lifted until the hole was completely filled with explosive to a level 1 ft. below water. In this way dynamite was distributed for the full depth of the mud in a vertical line, and the blasting effort was thereby distributed in a most efficient manner.

The holes were made and the charges placed by means of a raft made from telephone poles. By properly spacing the openings between the cross-planks of the flooring of the raft, the raft when set on line could be used as a gage for spacing the charges. The custom was to load a line 50 ft. long at a time. A greater length of shots was not practicable because the work was near a main road and only 1,500 ft. from a group of houses. The plan called for loading both the center line and the side lines at the same time, but the lines were to be fired singly. Although the lines

Fig. 1—Firing a blast to clear out mud for widening preliminary fill across Rhode Island salt marsh.

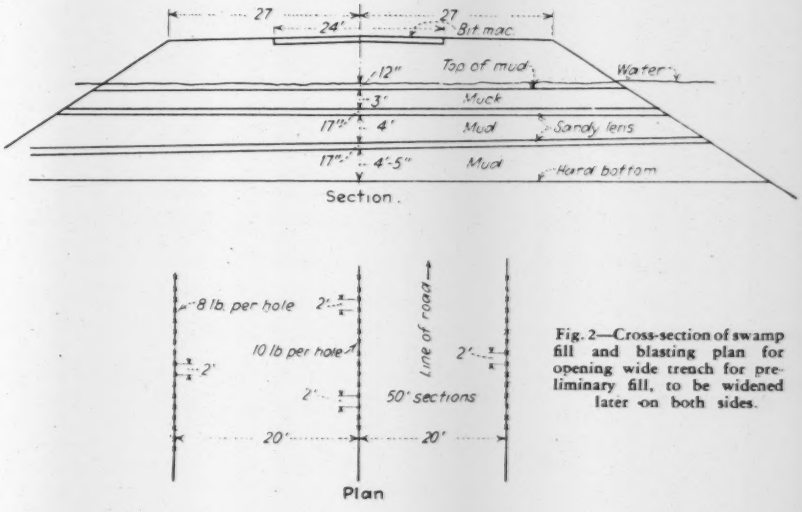


Fig. 2—Cross-section of swamp fill and blasting plan for opening wide trench for preliminary fill, to be widened later on both sides.

were 20 ft. apart, in a number of cases the shots propagated and all three lines exploded at once. The only detrimental effect was a greater concussion and the possibility of damage to the houses within the area.

Along each line the charges were placed 2 ft. apart. The amount in the individual holes along the center line, although varying somewhat with the depth of the mud, was approximately 1 lb. to the foot of depth, and thus in a 10-ft. depth of mud a 10-lb. charge was placed. The side lines were loaded proportionately with 8 lb. per hole.

An examination of each area blown was made on the day following the blasting. This showed a condition that had not been observed on any previous fill-settlement work. For example: an original sounding would show 3 ft. of fluid mud below the water line, an 18-in. lense of sand, another 3 ft. of fluid mud, another 12 in. lense of sandy material, a further 4 ft. of muck, a total of 12½ ft. from water line to hard bottom. The examination after the shot showed 4 or 5 ft. of water, 4 ft. of liquid mud and from 3 to 4 ft. of gritty stiff material through which it was difficult to push a rod to the original depth of 12½ ft. An explanation of this might be that the lenses of sandy material above mentioned had been broken up, and in falling back into the trench had settled compactly on the bottom of the trench.

This trenching operation required about 23 days. Although it was planned to use ditching dynamite throughout, it was necessary toward the end of the operation to use one-half Gelex A and one-half ditching, placing the Gelex A in the bottom of the holes with the ditching dynamite at the top. This method of blasting a wide trench across the fill proved very satisfactory, and upon the completion of the operation there was an open ditch full of water and liquid mud some 50 ft. wide and some 10 to 12 ft. deep.

Placing the fill

The placing of the fill was started, and some 1,000 to 1,500 cu.yd. a day were placed, using trucks and bull-dozer. The fill was handled in such a way that the liquid mud was forced forward of the toe of the fill, and extreme care was exercised in keeping the fill from being dumped on the mud itself. It had been hoped to keep a continuous check on the depth of the fill by means of a series of gage pipes. A number of 2-in. pipes were threaded at one end and welded to 18-in. square iron plates. It was planned to place these immediately in front of the fill and to allow the fill as it was placed to force the plate into the muck at the bottom of the fill. In this way it was planned to keep a check on the settlement of the fill. Should a stratum of unstable material be found under the fill, it was hoped that charges could be laid at such places by loading through the pipes. This scheme was unsuccessful, as the plates instead of "staying put" would slide along the mud in front of the fill. It was impossible also to keep the pipes vertical.

The placing of the fill, of course, forced the liquid mud ahead of it, and as this muck increased in quantity a method of relief had to be developed. Heretofore it had been the custom to set off charges under the fill proper at one-half day intervals for the purpose of expelling the muck. On this job, however, very little unstable material was found under the fill proper, and the charges were placed directly in the bank of muck in front of the fill, as shown in Fig. 3. An endeavor was made at first to use the same T core bars for loading, but these proved unwieldy, and lack of water caused the core bars to become plugged.

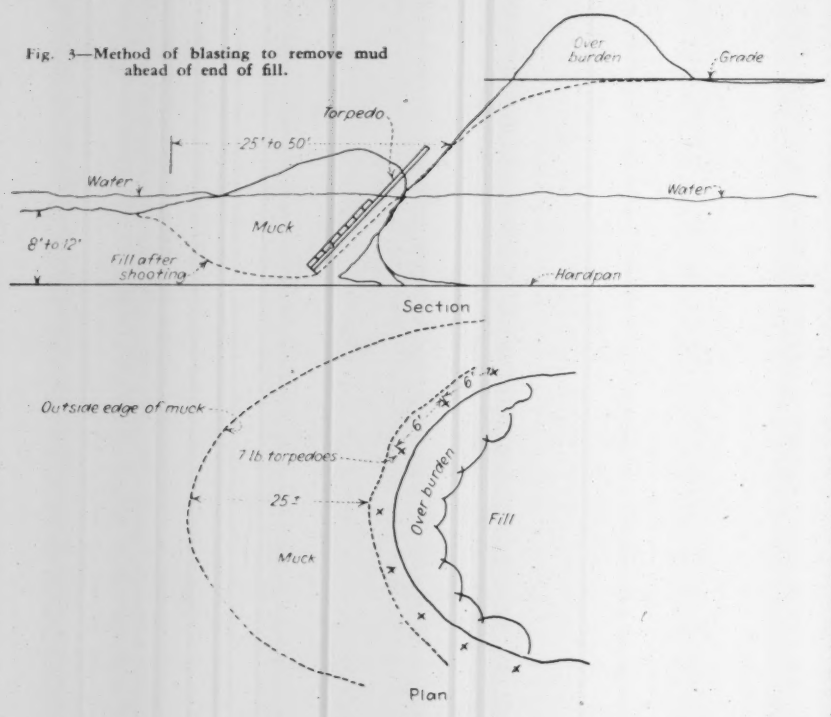


Fig. 3—Method of blasting to remove mud ahead of end of fill.

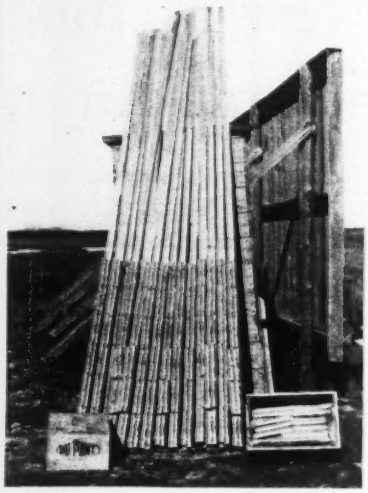


Fig. 4—Torpedoes made up by tying sticks of dynamite to wood furring strips.

The resident engineer on the job, E. Anthony, then developed a very effective torpedo to accomplish the desired results. Using 1x2-in. furring strips, 10 ft. long, and tying the dynamite two sticks at a time to these furring pieces, he constructed a torpedo from 6 to 8 ft. long varying with the amount of dynamite used (Fig. 4). Thus, the use of 7 lb. of dynamite would make a 6-ft. torpedo. The torpedoes were pushed by hand into the loose muck directly in front of the toe of the fill and as close to the fill as possible. A series of six to eight of them was thus placed across the fill and when exploded would give some 40 to 50 ft. of open water in which to continue the filling operation. These torpedoes were very effective and allowed a great deal of flexibility in the placing of the charges.

Except for one 50-ft. stretch where the fill had evidently pocketed a considerable quantity of mud there was no place where the fill over which the material was being hauled showed any signs of settlement. Ordinarily, where a fill is built upon unstable material it will quake under the trucks. Continued observations on the part of the engineers in charge did not disclose any quaking except at the point mentioned above. It seemed quite certain that the new fill was securely locked in place. This method of blowing the lose muck away from the toe of the fill was used until about 50 ft. from the original ground.

At this point the muck became

Fig. 5—Placing torpedoes in mud wave that is being blasted ahead of end of fill.

pocketed between the front of the fill and the shore, and in spite of successive loads it became too stiff to move. Several methods of blasting were tried, but these proved unsuccessful. The charges seemed only to blow small holes in the extremely tacky mud and gave no lifting effect. As the depth of this material was only about 3 ft. it was decided to fill over this section to hard ground and blast underneath, if necessary. The results so far showed that a stable fill had been placed varying from 6 to 15 ft. in depth and from 45 to 50 ft. in width across this swamp.

Widening gave trouble

The width between the shoulders of this fill when completed was to be 54 ft. on top. To be certain that this added material on the sides did not drop out of sight as soon as the mud became agitated, a row of torpedoes was placed immediately alongside the shoulders, the shoulder fill was loaded with excess borrow and the charges were fired. Torpedoes (8 to 10 lb.) were spaced 3 ft. apart. The new fill dropped into place as expected, but after proceeding approximately half-way across the fill with this semi-ditching method the whole fill began to quake, showing that the side support of the original fill core had been destroyed. The shoulder shooting was continued, however, to completion, and the fill was widened out to its required width and brought up to grade. This shoulder work was completed about Dec. 5, 1932.

An investigation was made of the quaking, and it was found from test pits that 10 to 14 ft. of good fill material rested on 2 to 3 ft. of stiff mud. The only method known for eliminating such mud pockets was to explode 15- to 20-lb. charges on 15- to 20-ft. centers in these muck areas. During the operation of placing these charges on an experimental 50-ft. section the weather turned cold and the fill froze. Upon exploding the charges no beneficial results were obtained and craters were formed in the fill. The work was stopped for the winter and has not been resumed. The fill during the period from December to March was frozen and thawed a number of times. Frequent examinations have been made, and there appears to be no evidence of unequal settlement on any portion of the fill. All indications point to the fact that the stabilizing effect of the winter weather will remove any necessity for blowing under the fill next spring.

Blasting reduced cost

Based on the original estimate of the complete removal of the muck and the unstable material, it was expected that 75,000 cu.yd. of fill would be needed. It was also estimated that about 40,000 cu.yd. of unstable material had either to be removed by dredging or blasting. No contractor appeared willing to remove this material by dredging for less than 90c. per cubic yard, or a total cost of $32,000. So far the cost of blasting, including dynamite, labor, exploders and material, has been $15,000. In addition, the amount of fill will not be more than 50,000 cu.yd. The saving of fill, of course, has been caused by some salvage of the better materials in the swamp and further by the system of loading the fill into place. It is estimated that some $20,000 has been saved by using dynamite on this project instead of dredging.

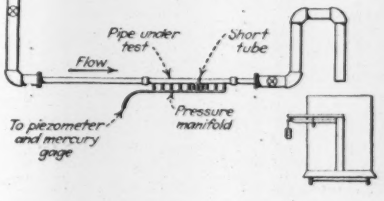
Hydraulic Losses in Short Tubes Determined by Experiments

By John A. Oakey
Instructor in Civil Engineering, Purdue University, Lafayette, Ind.

RESEARCH recently conducted at the hydraulic laboratory of the University of Wisconsin provides data on the losses involved in the flow of water through short tubes in the sides of pipes.

The experimental apparatus was as illustrated in Fig. 1. Iron-size brass pipe in 5-ft. lengths was used in all the tests. Each short tube was three diameters in length at its shortest point and was mounted at right angles to the pipe at a distance of 3 ft. from the upstream end. Entrance conditions to the tube were sharp-edged. In all cases the test pipe was preceded and followed by a run of iron pipe of the same internal diameter. The upstream section of the iron pipe removed any possibility of error that could be attributed to turbulence caused by the upstream control valve. Pressures at eleven points in the pipe were determined by means of an 8-ft. piezometer or by an open mercury manometer. Rates of discharge both from the tube and from the pipe were determined by weight.

Fig. 1—Apparatus on which experiments were conducted.



Four series of runs were made with the following conditions:

Series	Pipe Diameter, D, In	Tube Diameter, d, In.	Ratio of d to D
A	1.590	0.375	1 to 4.24
B	1.057	0.375	1 to 2.82
C	1.590	0.875	1 to 1.82
D	1.057	0.875	1 to 1.21

In each series the tests were made with velocities in the pipe varying from 0 to about 40 ft. per second and with heads varying from 0 to about 20 ft. A total of 204 runs was made.

The tables on p. 718 give values of C_d, K_1, K_2 and K_r. The common variable against which these factors are recorded is $\frac{q_2}{q_1}$, where q_1 is the rate of discharge in the pipe ahead of the tube and q_2 is the rate of discharge from the tube.

C_d = coefficient of discharge of the tube.

$$\text{Lost head in the pipe} = K_1 \frac{v^2_1}{2g}$$

$$\text{Rise in pressure in the pipe} = K_2 \frac{v^2_1}{2g}$$

Lost head in the tube $= K_3 \frac{v^2_3}{2g}$

v_1 is the velocity in the pipe ahead of the tube, and v_3 is the velocity of the jet issuing from the tube.

In the following discussion, subscripts 1, 2 and 3 refer to the following points: point 1—in the pipe immediately before the tube; point 2—in the pipe immediately after the tube; point 3—in the jet issuing from the tube.

From basic considerations, the total power at point 1 must equal the power taken from the pipe by the tube plus the theoretical power remaining in the pipe at point 2.

$$\text{Power at point 1} = q_1 \omega \left(\frac{v^2_1}{2g} + h_1\right)$$

Theoretical power at point 2 $= q_2 \omega \left(\frac{v^2_2}{2g} + H_2\right)$, where H_2 is the theoretical pressure head at point 2.

Power extracted by tube $= q_3 \omega \left(\frac{Cv^2_1}{2g} + h_1\right)$, where C is that portion of the velocity head at point 1, which is utilized by the tube.

When these values are used, the following equation results:

$$q_1 \omega \left(\frac{v^2_1}{2g} + h_1\right) = q_2 \omega \left(\frac{v^2_2}{2g} + H_2\right) + q_3 \omega \left(\frac{Cv^2_1}{2g} + h_1\right)$$

The head under which the tube discharges—namely, $\left(\frac{Cv^2_1}{2g} + h_1\right)$—was determined as follows: The total pressure head in the pipe, h_1, is utilized by the tube. Also, a portion of the velocity head, $\frac{Cv^2_1}{2g}$ is utilized by the tube. The value of C must be assumed. It is known that when $\frac{q_3}{q_1} = 1$, $C = 1$. It is also known that when $\frac{q_3}{q_1} = 0$, $C = 0$. Therefore, it will be assumed in all cases that $C = \frac{q_3}{q_1}$.

When this value of C is substituted and the equation is simplified, there results

$$(H_2 - h_1) = P = \left(\frac{q_1 + q_3}{q_1}\right)\frac{v^2_1}{2g} - \frac{v^2_2}{2g}$$

In this equation, P is the theoretical rise in the hydraulic gradient between points 1 and 2.

The equation may be further simplified by substituting for v_2 its equal

$$v_2 = \frac{q_2 v_1}{q_1} = \left(\frac{q_1 - q_3}{q_1}\right) v_1$$

When this substitution is made and the equation is simplified, the equation becomes

$$P = \left(\frac{3q_1 q_3 - q^2_3}{q_1{}^2}\right)\frac{v^2_1}{2g}$$

If the ratio between the discharge from the tube and the discharge in the pipe before the tube is given by

$$R = \frac{q_3}{q_1}, \text{ then}$$

$$q_3 = Rq_1.$$

If this value of q_3 is substituted, there results

$$P = (3R - R^2)\frac{v^2_1}{2g}$$

In other words, the theoretical rise in the hydraulic gradient between points

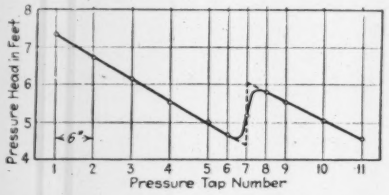


Fig. 2—Typical hydraulic gradient takes sharp rise at point of tube discharge.

1 and 2 is a coefficient times the velocity head at point 1. The coefficient is dependent upon the ratio of the flow from the tube to the flow in the pipe before the tube.

The actual rise in the hydraulic gradient, p, is given by $p = h_2 - h_1$.

h_1 and h_2 are determined by projecting the upstream and downstream hydraulic gradients, respectively, to the tube. This is illustrated by the accompanying typical hydraulic gradient, Fig. 2. Since P can be expressed in terms of the velocity head at point 1, it is logical to express p also in terms of the velocity head at point 1, or

$$p = K_2 \frac{v^2_1}{2g}$$

The difference between the theoretical rise and the actual rise in the hydraulic gradient is the lost head in the pipe, or, h_f in pipe $= P - p$.

Since both P and p are expressed in terms of the velocity head at point 1, the lost head in the pipe can also be expressed in the same terms, or,

$$h_f \text{ in pipe} = K_1 \frac{v^2_1}{2g}$$

The coefficient of discharge of the tube is determined by the equation

$$q_3 = C_d a_3 \sqrt{2g\left(\frac{Cv^2_1}{2g} + h_1\right)}$$

Since there is no contraction of the jet issuing from a short tube, the coefficients of discharge and velocity are equal. Therefore, the lost head in the tube is

$$h_f \text{ in tube} = \left(\frac{1}{C^2_d} - 1\right)\frac{v^2_3}{2g}$$

which when expressed in terms of the velocity head of the jet is

$$h_f \text{ in tube} = K_3 \frac{v^2_3}{2g}$$

The only factor that varies the values of the coefficients is the ratio R. Actual discharges and pressures have no effect on the coefficients. For instance, with a relationship between tube diameter and pipe diameter of 1 to 4.24 (which is the relationship existing in series A) and a ratio of q_3 to q_1 of 0.5, the coefficients will be: $C_d = 0.85$, $K_1 = 0.40$, $K_2 = 0.87$, and $K_3 = 0.37$. These values are correct regardless of actual values of D, d, q_1 or q_3 as long as these ratios obtain.

HYDRAULIC COEFFICIENTS DETERMINED BY TESTS ON SHORT TUBES IN THE SIDES OF PIPES

Series A

$\frac{q_3}{q_1}$	C_d	K_1	K_2	K_3
0	0	0	0	—
0.1	0.80	0.08	0.20	0.56
0.2	0.83	0.16	0.40	0.45
0.3	0.85	0.24	0.58	0.40
0.4	0.85	0.32	0.74	0.37
0.5	0.85	0.40	0.87	0.37
0.6	0.86	0.50	0.95	0.36
0.7	0.86	0.65	0.96	0.36
0.8	0.86	0.82	0.93	0.36
0.9	0.86	1.02	0.87	0.36
1.0	0.86	1.25	0.75	0.36

Series B

$\frac{q_3}{q_1}$	C_d	K_1	K_2	K_3
0	0	0	0	—
0.1	0.73	0.09	0.21	0.87
0.2	0.80	0.19	0.37	0.56
0.3	0.82	0.32	0.49	0.58
0.4	0.83	0.45	0.60	0.45
0.5	0.83	0.57	0.70	0.44
0.6	0.84	0.68	0.78	0.42
0.7	0.84	0.79	0.83	0.41
0.8	0.84	0.90	0.85	0.40
0.9	0.84	1.05	0.83	0.40
1.0	0.85	1.23	0.77	0.39

Series C

$\frac{q_3}{q_1}$	C_d	K_1	K_2	K_3
0	0	0	0	—
0.1	0.56	0.09	0.20	1.90
0.2	0.70	0.19	0.37	1.05
0.3	0.75	0.30	0.51	0.78
0.4	0.77	0.43	0.61	0.70
0.5	0.78	0.56	0.69	0.64
0.6	0.79	0.69	0.74	0.60
0.7	0.80	0.83	0.78	0.57
0.8	0.80	0.98	0.76	0.55
0.9	0.81	1.16	0.72	0.54
1.0	0.81	1.36	0.63	0.52

Series D

$\frac{q_3}{q_1}$	C_d	K_1	K_2	K_3
0	0	0	0	—
0.1	0.41	0.08	0.22	—
0.2	0.53	0.17	0.39	2.40
0.3	0.61	0.28	0.53	1.66
0.4	0.66	0.40	0.64	1.30
0.5	0.68	0.55	0.71	1.14
0.6	0.70	0.70	0.74	1.05
0.7	0.71	0.86	0.74	0.98
0.8	0.72	1.03	0.72	0.92
0.9	0.73	1.20	0.68	0.87
1.0	0.74	1.38	0.62	0.82

New Water Supplies in New York State

Twenty new public water supplies, involving an expenditure of more than $11,000,000, were put into operation in various municipalities throughout the state of New York during 1932, according to *Health News*, the weekly publication of the New York State Department of Health. The total number of public water supplies in the state is now 670, with more than 900 communities being served. During the year four communities—Albany, Canastota, Phoenix and Ticonderoga—abandoned old supplies from polluted or unsatisfactory sources and developed new supplies. Ten communities heretofore without a public water supply developed sources and constructed distribution systems. Six other communities built distribution systems and made arrangements for the purchase of water from near-by municipalities or companies.

Letters to the Editor

Engineering Courses for Engineers

Sir—In my opinion the object of an engineering school is to give students a foundation for the practice of the engineering profession. I do not understand the object to be the creation of executives or the preparation of students for any other profession or business. Graduates of such schools do become executives, do enter other professions and do take up many kinds of business enterprises, for which, by the way, their engineering education most certainly fits them. But these are only incidental, and the real object should always be kept in view—that is, to train young men to become engineers. The curriculums of our schools always should be changing, but I believe the position taken by Professor Hammond in your issue of April 20 to be fundamentally sound.

Considering a civil engineering course as an example, there should be found in it, beside the usual fundamentals in natural science and pure mathematics, not only courses in structures, hydraulics and metallurgy but a considerable amount of the principles usually taught in schools of mechanical and electrical engineering. In such a four-year course the time given to more general subjects necessarily must be limited. In the civil engineering subdivision in Rensselaer Polytechnic Institute, accounting, business administration, architecture, economics and three courses in English and English literature absorb nearly all the time allotted to subjects other than technical ones.

If a student wishes to have a wider knowledge of languages and literatures, he should first take an academic course; but I do not believe in attempting to do too fundamentally difficult things in any engineering course.

Times are changing—they have been changing for some æons—and the amount of engineering information demanded of a young graduate is changing also in that it requires a wider knowledge of professional subjects. In fact it is recognized that those students who supplement their undergraduate work by taking graduate engineering courses, one or three years in duration, are likely to advance more rapidly in their profession.

I am writing now of the main subdivisions in engineering. There is room for administrative courses and industrial courses, but these are not properly engineering courses, if, in them, subjects other than engineering ones predominate.

Yes, times are changing. The natural and social sciences are forcing themselves into the academic curriculums and are forcing out of them subjects which used to be considered the backbone of a "liberal education." And it is beginning to be understood that there are more kinds of a liberal education than one kind, and that whatever kind of an education a young man may have had in the schools he is still illiberally educated in many particulars.

PALMER C. RICKETTS,
Rensselaer Polytechnic Institute.
Troy, N. Y.,
May 1, 1933.

Concrete Column Spirals

Sir—In your issue of April 13, 1933, a letter appears from F. E. Richart, of the University of Illinois, in reference to the design of spiral columns. Professor Richart questions the desirability of employing the very high percentage of spiral reinforcement recommended by a previous correspondent. The writer, who for the past twenty years has been very much interested in the design of spiral columns, would like to support his view on this point. Professor Richart, however, deprecates the use of what is known as the "Considère Type" formula, presumably on the ground that it permits the use of any percentage of spiral, however high, provided such reinforcement can be got into the column. Actually, M. Considère's formula in relation to spiral columns was empirical and predicted the ultimate strength of the column. Although 30 years old, this formula is identical in form with the most recent formulas, being based on the crushing strength of plain concrete, the yield point of the reinforcement and an increased effectiveness of 2.4 for the spiral over the vertical rods. It is to be presumed, therefore, that the Considère formula referred to is that giving an increased permissible stress to the spiral core according to the percentage of spiral and the spacing of the coils.

It may not be generally known that in practice M. Considère always limited the maximum quantity of spiral reinforcement in any column. In effect, this limitation restricts the load contributed by the spiraled core to a fraction (usually one-half) of the ultimate concrete strength over the gross area of column.

There are, of course, other restrictions such as the minimum spacing of the coils, which may limit in particular cases the percentage of spiral reinforcement that should be employed. Furthermore, an upper limit is placed upon the amount of longitudinal reinforcement, usually about 8 to 10 per cent of gross section.

In your previous issues of Sept. 8, 1932, and Jan. 23, 1933, on pp. 277 and 257 respectively, a number of spiral columns are described, these being calculated to carry a load of 1,150,000 lb., using a 2,500-lb. concrete. A suitable "Considère" column for this load, if short and axially loaded, would be a 26-in. octagonal section, reinforced with a maximum spiral of $\frac{5}{8}$-in. diameter at $1\frac{3}{4}$-in. pitch and $1\frac{1}{4}$-in. diameter longitudinal bars. This column calculated on the increased core stress formula would have a safe load of 1,156,000 lb. Calculated upon the ultimate strength formula, with factor of safety of 3 and spiral effectiveness of 2, the safe load would be 1,195,000 lb.

It will be seen, therefore, that the older method gives results in close agreement with the latest formulas and, if employed within proper limits, the trouble feared by Professor Richart would not exist.

W. L. SCOTT,
Chief Engineer,
Considère Constructions Limited.
London, England,
April 29, 1933.

Secondary Stresses by Fixed-End Moments

Sir—The time required for the calculation of secondary stresses (those caused by bending stresses in the plane of the main truss due to rigidity of joints) is generally overestimated. If the designer is acquainted with the method of fixed-end moment distribution developed by Prof. Hardy Cross, the calculations for an ordinary truss can be made in a few hours by using the average of the algebraic sum of the third and fourth cycles. (For additional information concerning the Cross method of figuring secondary stresses see *Transactions*, Am.Soc.C.E., Vol. 96, 1932, p. 108.)

The writer has calculated the secondary stresses of a 296-ft. Parker truss for an equivalent uniform load and also the three- and two-hinged Hell Gate arch bridge for dead load, and he has carried the computations to seven cycles. On comparing these results with the average of the algebraic sum of the third and fourth cycles there is very little difference.

In some members, such as 4-6 at joint 4 for the dead-load secondary stress in the three-hinged Hell Gate arch bridge, the moment at the end of the third cycle has the opposite sign from the moment at the end of the fourth cycle, and the average of the algebraic sum of the two cycles adds up to nearly zero, which indicates that the secondary stress is very small and which agrees practically with the result as given on plate XLV in *Transactions*, Am.Soc.C.E., Vol. 82, 1918, namely, 8 lb. per sq.in.

It is the large secondary stresses that require the additional material; and if the average of the algebraic sum of the third and fourth cycles shows large stresses, which are above those allowed by the specifications, then additional material should be added to the member.

A. W. FISCHER.
Philadelphia, Pa.,
April 28, 1933.

Engineering News-Record

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The Sanitary District Decree

A DECISION of far-reaching implications was announced by the United States Supreme Court last week and was reported in the news pages of our last issue in connection with the Chicago Sanitary District lake diversion. In regard to the responsibility of a state when one of its political subdivisions gets into difficulties, the principles stated by the court are capable of wide application. The power of the court to order the construction of sewage plants when such construction is necessary to effectuate the court's injunction is stated in no uncertain terms. Financial and local legal handicaps are given scant respect, as they are considered to be within the power of the state to remedy. Stream pollution and water-diversion problems so frequently involve more than one state that the words of the court in directing the state of Illinois to make the necessary provisions for the new construction are of compelling interest to all engineers engaged in water or sewage problems.

Industry Is Organizing

INDUSTRIAL groups have been studying the Recovery Act intensively in the two weeks since its introduction, and two facts are emerging. One is that industry likes the act and welcomes the discipline that it promises. There is general acceptance of the basic fact that the primary ends sought are more wages for labor and greater stability of operation, and equally general realization that the codes must be workable and cannot be drawn, as in the past, with a pious hope that they will work but an inner knowledge that they will fail. Industry knows that the choice is between autonomy and imposed regulation. The second fact is that the construction industry, with its many component parts, is becoming convinced that there must be codes of two types. For, as we pointed out last week, production and selling conditions in this industry vary widely, and they lack a common denominator that would make a single trade association successful. On the other hand, wages, hours and conditions of labor are susceptible to uniform practice. So it is proposed by several groups that each of them draft a code covering its specific problems, and that the groups combine on a code that can handle all common problems. Such an arrangement appears ideal; it will simplify the federal administrator's problem, and it will require minimum readjustment of the present industrial set-up.

Safer Tunnel Driving

ALL CONCERNED with the hazardous driving of the Hetch Hetchy tunnel are to be commended for their success in turning a dangerous and difficult task into a safe one. It is regrettable that a serious accident involving a heavy loss of life occurred before the dangers of the job at hand were fully realized. Gassy tunnels, while uncommon, are not rare. The necessary precautions sufficient to cope with the gas hazard vary from simple but proper ventilation to the adoption of strict coal-mining methods, involving permissible types of powder, equipment and lighting. Following the bad explosion at Hetch Hetchy, the management conducted operations with the highest safety precautions available. Obviously, these precautions decreased the efficiency of the work and correspondingly increased its cost, but where human life is at stake there can be no compromise with safety on such a score. Dangerous gas is one of the possible hazards in tunneling that may never be left out of mind, as the Hetch Hetchy experience once more demonstrates.

Coast Damage

ACCUMULATING reports indicate that the past winter was the worst of many years in respect to coast damage. Buildings and other shore structures went down in great numbers, and erosion took an abnormal toll of land area. Definite figures are lacking, but it is well established that a succession of extreme storm tides wrought exceptional destruction all along the Eastern coast. This is a story that repeats itself at irregular intervals, from a decade to twenty-five or thirty years. In the intervening years the more moderate annual damage, itself amounting to many millions, causes the danger of more extreme havoc to be forgotten and defensive action to be deferred, the more easily because the losses are not prominently before the eyes of the multitude. Yet they are a very direct public concern, not only because the shore is one of our greatest common assets but also because local protective measures are of little effect, since the resistance of any one section of shore is interwoven with the resistance of adjoining sections, so that nothing short of large-scale regional protective action can be relied upon. The state, therefore, appears to be the logical authority to direct shore-protection activities. As few states have yet taken cognizance of the subject, our shore line remains freely exposed to the inroads of wave and storm and continues to suffer heavy losses annually. Correction of this bad condition constitutes one of the major fields of necessary public-improvement construction.

Adult Education

CHICAGO opened its Century of Progress Exposition last week. For five months it will be host to the world in a remarkable demonstration of adult education. Usually this kind of education is associated with social and economic problems, but at Chicago the instruction will be in the scientific field. The need for such instruction is great. In such a world as ours, where almost every activity is affected by the products of science, it is difficult to make economic or social teachings practical without taking into account the facts of science and their influence on living. The Chicago fair does more than explain scientific products and processes. It shows the relationships among the various branches of science and brings into relief the affiliation between science and industry. The Columbian Exposition of 40 years ago and all other fairs have aimed to exhibit a

cross-section of the world as it existed at the time. The Century of Progress Exposition reorients this purpose by showing how the world operates. Its sponsors hope that it will minister to the educational needs of millions, but many millions of others will have opportunity to read of it. This journal devoted its issue of March 2, 1933, to the physical plant, and *Electrical World* tells the story of the fair's remarkable lighting displays in its May 27 issue. These and other publications will make the fair widespread indeed, and the resultant better understanding of the relationships between science, industry and the individual will make the world a better place in which to live.

The Recovery Bill Advances

PROMPT PASSAGE of the Recovery Bill by the House last week is evidence of the determined purpose behind this essential legislation. The wisdom and broadly objective character of its provisions emerge more and more clearly as one studies its terms. Yet voices are being heard on all sides saying, "It won't work, any more than did the construction section of the Relief Act of 1932."

Many fear that it will operate too slowly, except for the money provided for highway construction, which all admit can be put into productive channels quickly. It is said that the limitation of direct grants to states and municipalities to 30 per cent of the cost of labor and materials and the implied requirement that the remaining 70 per cent must be borrowed either from the administrator of the act or from private sources will effectually keep cities and states from inaugurating public construction under the act. Some of those who express such doubts speak from experience in trying to get loans from the R.F.C.

These pessimistic views doubtless would be justified were it not for the revolution that has taken place in Washington. Behind the proposed Recovery Act is a will to do, a driving desire to make the act produce results, that never was back of the Relief Act. This desire for accomplishment was the motive for writing into the bill unprecedentedly broad powers for the administrator. By virtue of these powers and the responsibility which the act implies, it would be possible, in case a city council finds it difficult to obtain authority to borrow for a needed sewage-disposal system, for the administrator of the act, with the approval of the state, to go in and build the project as a federal undertaking, making the city engineer a federal agent, and control it until the city can finance and take over the project.

This example serves but to show what can be done under the act—and what will be done because of the new spirit that is behind it. With such spirit as a driving force behind its application, the inhibitions that made the 1932 act ineffective need cause no concern. The Recovery Act will be *made* to produce results.

How large is the local responsibility that the act implies can also be realized more clearly as time goes on. There is no question but that Washington will do its part in making the Recovery Act effective as quickly as possible after passage of the bill and that the state highway departments will put the major part of the $400,000,000 for highway and grade-crossing work under contract before mid-summer. But the federal work and highway construction form a relatively small part of the total work contemplated under the act. The major part of the work included in reaching the total of $3,300,000,000 authorized to be spent under the Recovery Act is state and city work—and this must be put forward by the local communities if it is to be considered promptly by the federal administrator.

Water supply, sewage disposal, paving, street widening, hospitals, schools and playgrounds, housing, parks and other community facilities, all can and will be financed if they are presented to the administrator in such form as to indicate that they can be started quickly. Responsibility for this rests squarely upon the shoulders of the local state, city and county officers. Some few city officials, like Charles M. Reppert, of Pittsburgh, are fully aware of this fact and have asked for an additional force of engineers to prepare plans for such work. Some states have set up committees to seek out needed public work. But generally the need for prompt action, now that passage of the bill is assured, is not recognized.

It is here that engineers both in and out of the public service, as individuals or through local organizations, can be of immediate assistance. They have the power to bring the possibilities of the pending Recovery Act to the attention not only of their local governing body, but also of the local press. When every community is aroused to its responsibility in bringing about national recovery, the act can be made immediately effective and rapid economic restoration assured.

A Law for Earthquake Safety

A SWEEPING legislative enactment requiring all buildings to be designed against lateral forces has been passed by the California legislature as an emergency measure resulting directly from the Long Beach earthquake. This makes the second important law controlling building construction to result from the March 10 disaster, the first being the act to require state approval of all school building plans.

Hereafter, all buildings in the state, with such few exceptions as to be negligible, must be built to resist a lateral force of 2 per cent of the total vertical load, or 20-lb. wind load, the more severe effect to control. Except to provide that the combined forces shall not result in overstressing the members by more than one-third the allowable working stress of the local ordinance, the act offers no help in interpreting the requirement.

In principle the law is highly commendable. Its practical aspects are more doubtful. Drawn in haste to meet an emergency, the act promises to involve serious administrative problems and to affect present practice and building costs extensively. Amendment to make it less burdensome is certain to come as soon as the state's requirements can be studied more carefully.

The most glaring defect of the bill is the uniformity with which it applies to the entire state, though it is well known that there is wide variance in the susceptibility of different regions to seismic disturbance. Hardly less objectionable is the lack of distinction between foundation conditions, the requirements being alike for solid rock land and soft fill. The indefiniteness of its application to practical design, especially in respect to stress intensities, will lead to varying interpretation by the municipal building departments that must administer the act, and designers will therefore be confronted with a complexity of rules and regulations. Out of experience in practical application of the law will be developed the final answer to the problem of earthquake-safe building. The present act is a promising start.

NEWS OF THE WEEK

Public Works Bill Gives Free Hand to Administrator

Washington Correspondence

IT has become apparent that Congress intends to leave the language of the new public works-industrial control bill very general in character. This course of action has been decided on in the interest of expediting passage of the measure and also to meet the desire of the White House for ample latitude in carrying out the program. As a result, most of the explaining and interpretation of the public works section will have to be done by the administrators to be named by the President.

All public work included

As the measure now stands, virtually every type of local construction work can be fitted into the program outlined in the public works section. It will no longer be necessary to show that the project is self-liquidating. A state or political subdivision may either borrow from the new agency or may obtain an outright grant with the qualification that such grants may not be for more than one-third of the cost of the project excluding land purchasing. As yet no light has been shed on what the guiding factors will be in determining when the aid is to be extended in the form of a grant and when in the form of a loan. It is understood, however, that a general statement of policy explaining this and other points will be forthcoming as soon as the bill has been passed.

Policy indicated

Meanwhile, there are certain broad indications of policy. In the first place, primary emphasis will be placed on the employment factor. Projects that will provide a relatively large amount of direct employment will be given first consideration. It is also apparent that preference will be given to projects that do not entail heavy maintenance or operation costs. Probably next in order of importance will come projects close to unemployment centers. This is in line with recommendations made by the President's advisors that as much work as possible be afforded to men in their home towns instead of making it necessary to move workers around to a relatively small number of large projects.

Small projects favored

Since the importance of decentralizing the work will be stressed, it is obvious that the administrator will strive to authorize a large number of small projects of around the $100,000 class. This does not mean, of course, that larger applications will be entirely discouraged. It is also evident that volume applications will be encouraged. Thus cities and governmental agencies will be urged to submit a large number of applications at the outset rather than sending in their proposals on a piecemeal basis. This will enable the administrator to start immediately in preparing a list of projects that best conform with the requirements of the act.

As passed by the House, the public-works section of the bill makes a larger portion of the highway money available to the populous states than did the original draft. The House amendment distributes that money one-fourth on the ratio that the area of the state bears to that of the whole country, one-fourth on a similar ratio of highway mileage, and one-half on the basis of the population ratio.

Chicago Sanitary District Bonds Authorized Without Referendum

The upper house of the Illinois state legislature has approved a bill authorizing the Chicago Sanitary District to issue, without referendum, $18,500,000 of bonds to be spent on the construction of the sewage treatment work for the district.

As noted last week, the United States Supreme Court has ordered the State of Illinois to provide the money necessary for the Sanitary District to carry out its sewage treatment program in accordance with the court's order issued in 1930.

New California Building Law Makes Lateral Force Design Mandatory

RESISTANCE for a lateral force equal to 2 per cent of the total vertical load or a 20 lb. wind load (the larger to control) must be provided in the design and construction of all buildings built in incorporated sections of the state of California according to a bill passed by the legislature as a direct result of the Long Beach earthquake. The combined vertical and horizontal stresses are not to exceed one and one-third (1⅓) times the allowable working stresses provided by the local ordinance. The few exceptions provided are for small buildings in rural communities or buildings already started. The bill has not yet been signed by the governor but as an emergency act will become effective immediately upon his signing.

The bill originated in southern California with the purpose of controlling reconstruction following the earthquake of March 10. Opposition was mainly in regard to the provisions of the bill and not to its intent. Questions as to making the bill uniformly applicable to the entire state, some sections of which have no record of serious seismic disturbance, and of reconciling it with the results of the long study made by San Francisco engineers in connection with a new city ordinance on the same subject formed subjects of controversy. After some slight changes in the original measure it developed that, in the rush of closing legislative action, any attempt to amend the bill further would kill it and, in the interest of having the measure as it stood or none, opposition was withdrawn.

Principal provisions of the act are as follows:

Section 1. Every building of any character, and every part thereof which is hereafter constructed in any part of the State of California, including every incorporated city, incorporated city and county, and county except such buildings as are hereinafter expressly excepted from the operation of this act, shall be designed and constructed to resist and withstand horizontal forces from any direction of not less than either two (2) per cent of the total vertical design load or twenty (20) pounds per square foot wind pressure on the vertical projection of the exposed surface, the horizontal force used to be the one that produces the greater stresses in the building.

Sec. 2. For the purposes of computing the resistance of any building to such horizontal forces as required by section 1 hereof, the computed stresses resulting from the combined vertical forces and horizontal forces shall not exceed one and one-third (1⅓) times the allowable working stresses as hereinafter provided.

Sec. 3. For the purposes of this act, allowable working stresses shall be those specified in the ordinances governing the erection and construction of buildings in the city or city and county in which the building is to be constructed or if in unincorporated territory then of the county wherein the work is done.

If no such ordinance is in effect at the place at which the work is done then the allowable working stresses shall be those specified by the Division of Architecture of the State Department of Public Works, which is hereby fully authorized and empowered to specify such allowable working stresses for the purposes of this act as to any city, city and county, or county in which no such ordinance is in effect.

Sec. 4. This act shall not apply to the following buildings:

a. Any building not intended primarily for occupancy by human beings and no part of which is located within the limits of an incorporated city or incorporated city and county.

b. Any building designed and constructed for use exclusively as a dwelling for not more than two families and no part of which is located within the limits of an incorporated city or incorporated city and county.

c. Any building on which work has actually been commenced prior to the effective date of this act.

Enforcement is placed under municipal buildings departments and where these do not exist the state division of architecture is to control.

The act, as evident from the wording, is general in provisions and questions of interpretation are many. Further, the requirements are minimum and for various sections of the state known to be subject to seismic disturbance these provisions will be exceeded by local ordinance, especially for poor ground conditions. In the case of larger buildings there is the question as to whether the designer will be permitted to put lateral stresses into frame or walls or both and in what proportion. For smaller structures of brick or timber definitely without structural frame new problems of analysis are involved.

County Highways in New York Placed Under State Control

The entire county highway system of the State of New York has been placed under the supervision of the Superintendent of Public Works by a bill passed at the recent session of the legislature. The county highway system includes those highways contructed or improved at the joint expense of the state, county and town or by the state and county. Hereafter the only control which the county supervisors will exercise over such highways is approval of the plans. Secondary roads are not affected.

Public Bid Calls in New York Must Specify Wage Rate Paid

Hereafter all calls for bids for public work in New York State must include a schedule of wages to be paid on the work. The rates so specified shall be the prevailing rates for the region in which the work is to be done as determined by the industrial commissioner.

Governor Lehman, in approving the bill, said "While I am somewhat doubtful as to whether or not the bill will ultimately work to the advantage of labor, I have been strongly urged by the representatives of organized labor to approve it."

Proposal to Build Sewage Plant To Be Considered at Toronto

A proposal to construct a $25,000,000 sewage disposal plant probably will be put before the rate payers of Toronto, Ont., on Jan. 1, 1934, according to a statement made recently by Mayor Stewart to the city council. For some months past engineers have been engaged in the preparation of a report for the city upon the city's requirements for sewage disposal and upon the possibility of contamination of its water supply from inadequate treatment of the city's sewage. Mayor Stewart stated that the report will be ready for the consideration of the council in a few weeks and it is understood that it will indicate the need for additional works for sewage treatment.

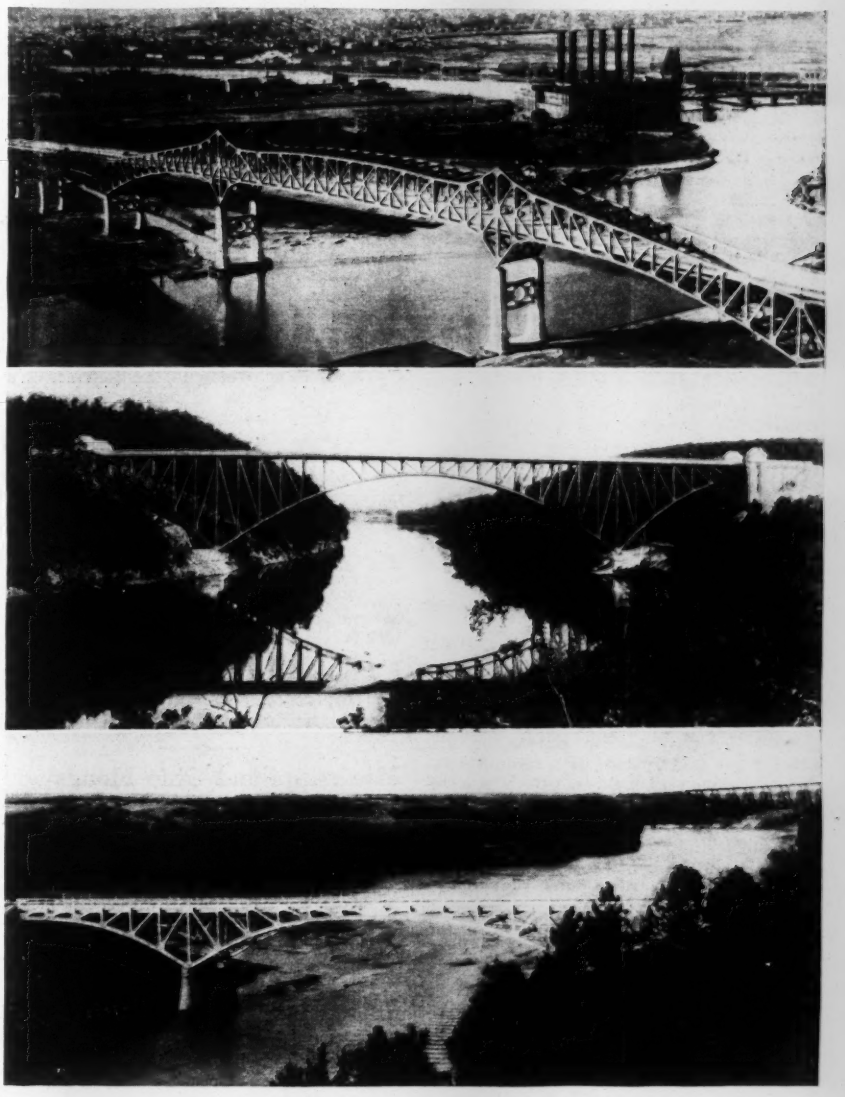
Large Dams to Be Discussed at Power Conference in June

The first congress of the international commission on large dams, an organization operating under the World Power Conference, will be held this summer in connection with the World Power Conference to be held in Copenhagen, Stockholm and Oslo, June 26 to July 8. The opening exercises of the conference will take place in Copenhagen on June 26, and the delegates will then proceed by special train to Stockholm where the technical sessions of the sectional meetings and of the congress on large dams will begin on June 28. The closing session will be held in Oslo July 7 and 8.

The World Power Conference this year is to be devoted largely to the subject of energy supply and power problems of industry, railways and marine transport.

Papers before the conference on large dams by American engineers are: Hydraulic-fill dams, by Prof. Glennon Gilboy, of the Soil Mechanics Laboratory, Massachusetts Institute of Technology; Internal temperature and the deformation of masonry dams, by Ivan E. Houk and B. W. Steele, of the Denver office, U. S. Bureau of Reclamation; and deterioration of concrete in masonry dams, by F. R. McMillan, Portland Cement Association, Chicago.

O. C. Merrill, 405 Lexington Ave., New York City, is secretary of the American committee, World Power Conference.



THREE BRIDGES GET STEEL INSTITUTE AWARD

Three awards for the most beautiful steel bridges built during the year 1932 have been announced by the American Institute of Steel Construction, New York, following a custom established some years ago.

The award for the Class A bridges, those costing over $1,000,000, went to the Hackensack and Passaic River spans of the high-level viaduct of the New Jersey State Highway Department designed and built under the direction of Jacob L. Bauer, state highway engineer. The McClintic-Marshall Corporation fabricated and erected the two bridges, while the approach viaduct was fabricated by the American Bridge Co. and the Phoenix Bridge Co. Honorable mention in this class went to the Lorain-Carnegie bridge at Cleveland, Ohio.

The Class B award, $1,000,000 to $250,000, went to the French King bridge, designed and built for the Commonwealth of Massachusetts under the supervision of A. W. Dean, chief engineer, and G. E. Harkness, bridge engineer, Massachusetts Department of Public Works. The McClintic-Marshall Corporation was the contractor for the superstructure. Honorable mention in this class went to the York St. high-level bridge in Hamilton, Ont.

The award for the Class C bridges, those costing less than $250,000, was made to the Bryan bridge built for the Nebraska Department of Public Works under the direction of J. G. Mason, bridge engineer, and Joseph Sorkin, designer. The bridge was fabricated by the Paxton & Vierling Iron Works, Omaha. Honorable mention in this class went to the Canterbury St. bridge over Morton St. in Forest Hills, Boston.

The jury of award consisted of Robert M. Carrere and J. K. Smith, architects; D. S. Trowbridge, C. W. Hudson, and F. E. Schmitt, engineers. Placques of award will be affixed to the bridges some time during the coming summer.

Brooklyn Bridge "Reopened" After 50 Years of Service

On May 24 officials of New York and of Brooklyn marked the beginning of the second half century of life of the Brooklyn Bridge by re-enacting the bridge-opening ceremony of fifty years ago.

Among the speeches made at the re-opening celebration, that of Palmer Ricketts, director of Rensselaer Polytechnic Institute, Troy, N. Y., was of special interest to the engineering profession. Dr. Ricketts spoke of the significance of the bold engineering work that led up to the construction of the bridge, outlining briefly the history of suspension bridges built previous to the construction of the Brooklyn Bridge in order to indicate what a long step in advance in the design of suspension bridges was made by the Roeblings when they undertook to build a bridge over the East River at New York. When the construction of the bridge was begun, Dr. Ricketts was a young professor at Rensselaer Polytechnic Institute and so not only was familiar with the engineering work but also knew intimately many of the engineers who worked with John A. Roebling and Washington A. Roebling on the construction. Because of this contact he was able to give interesting reminiscences of the individuals concerned in the work as well as of the construction operations.

Public Work Costing $70,000,000 Being Studied by Buffalo Council

Public works involving the expenditure of $70,000,000 by the City of Buffalo, N. Y., are listed in a resolution passed recently by the common council of that city for the appointment of a committee of five councilmen to make a survey and report the feasibility of the projects. Projects listed in the resolution include the following:

Sewage disposal projects, $25,000,000.
New police headquarters building, $500,000.
A new convention hall.
Reclamation of the entire water front, involving the building of a boulevard, municipal bathing beach, parks and elimination of waterfront tenement area.
Transfer of tracks of New York Central R.R. from waterfront to bed of Erie canal.
Cleaning of Delaware Park Lake.
Dredging and straightening the Buffalo River east of Seneca St. and building two bridges over the river.

Aid of the federal government will be sought in carrying out the projects.

Open-Market Cement Purchase Authorized for Illinois Work

The State Senate of Illinois, on May 23, passed the House Bill authorizing the state highway department to purchase its cement in the open market without the formality of calling for bids. The bill has been signed by the Governor. The legislation was introduced as the result of a controversey between the state government and the cement companies over the prices bid for cement for highway work. Because of the price and the uniformity of the bids made in response to these calls issued this year the governor in each instance instructed the state highway department to reject all bids.

New York Sales Tax Affects Materials for Contract Work

WHO is to pay the sales tax on materials going into construction work in New York State has been clarified by a ruling of the state tax commission issued on May 25. The legislature at its recent session passed a bill calling for a 1 per cent retail sales tax.

The commission has ruled that the sale of building supplies to a contractor is taxable if the latter is working under a lump-sum contract, but that if the contractor's charges to the client are segregated as to materials and service, it is the contractor's sale of the material to the owner which is taxable.

Receipts from sales of materials and supplies to owners to be used by them in erecting, altering, improving or repairing buildings or other improvements on land are taxable, according to the commission's ruling. Such sales of materials are considered by the commission as sales to final buyers and not sales for resale. Where a contractor or subcontractor uses part of the material purchased by him for work on lump-sum contracts and part for resale, the tax commission has set up regulations as to segregation of purchases in order to provide for proper payment of the materials tax.

Cost-plus contracts are treated the same as lump-sum contracts. The sale of materials to the contractor is classified as a sale to the final buyer and the percentage plus paid to the contractor on the cost of materials and supplies is for services rendered and is not taxable.

Mississippi and Ohio Floods

The recent floods in tributaries of the Ohio River, noted in these pages last week, have caused a second spring flood in the lower section of the main river. At Cincinnati the crest reached 54.1 ft. In the March flood the crest was 63.6 ft.

The flood crest of the Mississippi River is not expected to be abnormal. Isaac M. Cline, of the Weather Bureau station at New Orleans, estimates that the flood crest there will be between 17.7 and 18 ft. Flood stage for New Orleans is 17.0 ft.

Damage caused to highways and highway bridges in Ohio by this flood are estimated at close to a million dollars, or considerably in excess of the damage caused in the March flood. The total will be in the neighborhood of $1,300,000.

Columbus Sewage Disposal Plan Delayed by Bonding Difficulties

The plan of the city council of Columbus, Ohio, to call for bids from private companies for the construction and operation of a new sewage disposal plant for the city has been delayed by a question as to whether the bidding companies could furnish performance bonds. Under present conditions the city has been advised by a representative of the American Surety Co. that bonding companies are not writing performance bonds for terms longer than five years.

Loans of $772,500 Approved for Construction Work

The Reconstruction Finance Corp., on May 27, approved loans totalling $772,500 for nine self-liquidating projects. The loans approved are as follows: $108,000 to the city of Deer Lodge, Mont., for a waterworks system; $150,000 to the Arkansas State Teachers College, Conway, Ark., for a new dormitory; $135,000 to the James Madison Memorial Bridge, Inc., for a toll bridge across the Rappahannock River between Port Royal and Port Conway, Va.; $125,000 to the Wyoming Development Co. and Wheatland Industrial Co., Wheatland, Wyo., for an irrigation canal; $61,000 to Guin, Ala., for a water and sewer system; $150,000 to the Dixie Bridge Co. for a toll bridge between Niceville and Camp Walton, Fla.; and $6,500 to Waldo, Fla., for a new sewage and water supply system.

The citizens of Bloomington, Ind., have voted to accept the tendered loan of $428,000 from the R.F.C. for its projected sewage disposal plant. Plans are being rushed in order to get work started this summer.

Company Formed to Promote Modernized Timber Construction

American rights to the modern wood connectors, described in *Engineering News-Record*, March 30, 1933, p. 408, have been acquired by a new organization known as the Timber Engineering Co., a subsidiary of American Forest Products Industries, Inc. Wilson Compton, manager of the National Lumber Manufacturers Association, Washington, D. C., is president of the new company which was formed in an effort to stimulate the further and more intelligent use of wood in construction. An announcement states that it is intended to operate the company in such a way that no one group of lumber manufacturers, fabricators, distributors or others can secure a monopoly on modern timber construction. As new devices promising better or greater utilization of timber are developed, they will be investigated with a view to their acquisition. It is planned to introduce the connectors on such terms and under such conditions as to give this system of construction a maximum impetus.

The purpose of the Timber Engineering Co. is not to furnish engineering design services on specific projects but rather to perfect license agreements with qualified engineers who may be willing and able to specialize in this new system of construction. Under present plans the company will maintain a small engineering force at its headquarters and in field offices for the purpose of advising engineers and to check plans and specifications where connector systems are to be used. A reasonable charge will be made for the latter service and for using the patented connectors or methods of construction. The company will arrange for the manufacture and supply of the connectors. It will also inspect and certify the lumber used as to its suitability for a particular job and will identify it with a TECO trade mark.

Bids Received on More Tunnels for Colorado River Aqueduct

Bids totaling $5,222,771 on the Eagle Mountain, Hayfield and Mecca Pass tunnels of the Colorado River aqueduct project were opened on May 23 by the directors of the Metropolitan Water District of Southern California. Seven tunnel sections aggregating 10.72 miles in length are included. The longest is the Eagle Mountain tunnel, 4.98 miles long.

Low bidder on the Eagle Mountain job was John H. Griffiths and Sons, Chicago, with a bid of $3,360,245. Hunkin & Conkey, Cleveland, Ohio, submitted a low bid of $814,952 on unit No. 1 of the Hayfield tunnel, and Gordon & Shafner, Los Angeles, were low on the No. 2 unit of the same tunnel with a bid of $471,889. The No. 1 unit will be 1.82 miles and No. 2, 1.02 miles. Morrison & Knudsen, Boise, Idaho, were low on the Mecca Pass job with a bid of $575,685. This portion of the system is made up of three separate bores Mecca Pass tunnels No. 1, No. 2 and No. 3, totaling 1.11 miles in length.

Subway Project for Pittsburgh Revived to Create Employment

The city transit commission of Pittsburgh, Pa., has recommended to the city council that the $5,880,000 of credit remaining of a bond issue for subway construction authorized in 1919 be applied to the construction of a rapid-transit subway from the heart of the business section of the city out as far as Seneca St. as a means of creating employment. The commission estimates the cost of the whole program at $16,200,000. The bond issue authorization in 1919 only provided for work in the first and second wards so that extensions beyond Seneca St. would require additional authorization. Construction of a second section from Seneca St. to Craig St. is estimated to cost about $5,600,000.

Burned Pier at Oakland, Calif., To Be Replaced in Near Future

Plans to construct a fireproof pier terminal at Oakland, Calif. to replace the structure recently destroyed by fire have been announced by the Key System, Inc., which operates a passenger ferry service between San Francisco and Oakland with an interurban train service in the East Bay district. Work on the new terminal will start about June 1 and several hundred men will be employed for at least three months. Plans call for construction of an enclosed terminal to accommodate nine tracks, with passenger concourse, ramps and offices, all at an estimated cost of $200,000.

The old terminal was destroyed by a fire several weeks ago. Temporary ferry service was restored the day following the fire but some of the trains had to be eliminated because of lack of loading trackage at the end of the long trestle, and arrangements were made to handle this part of the service over the facilities of the transbay division of the Southern Pacific Company.

The pier site and long fill and trestle approach is nearly on the line of the San Francisco-Oakland bridge, now under construction.

SOCIETY CALENDAR

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, Chicago, Edgwater Beach Hotel, June 26-30.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual convention, Chicago, Palmer House, June 27-30.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, Chicago, Palmer House, June 27-July 1.

AMERICAN SOCIETY OF MUNICIPAL ENGINEERS, Milwaukee, Wis., Sept. 25-27.

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting, Chicago, Stevens Hotel, June 26-30.

AMERICAN WATERWORKS ASSOCIATION, annual meeting, Chicago, June 12-16.

NATIONAL COUNCIL OF STATE BOARDS OF ENGINEERING EXAMINERS, annual convention, Chicago, Stevens Hotel, June 26-28, 1933.

NATIONAL FIRE PROTECTION ASSOCIATION, Milwaukee, Wis., May 29-June 1.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, annual meeting, Chicago, Stevens Hotel, June 27-30.

ENGINEERS WEEK, Century of Progress Exposition, Chicago, June 26-July 1.

Construction League Committee To Meet During Engineers Week

The policy committee of the Construction League of the United States plans to meet in Chicago on June 28 during Engineers Week at the Century of Progress Exposition. Previously the date had been set for June 29.

Los Angeles Seeks to Reopen Settlement Over Dam Contract

Suit to recover $830,765 paid by Los Angeles, Calif., county to the contracting firm of Fisher, Ross, MacDonald & Kahn, Inc., in settlement of the original San Gabriel dam contract is to be instituted on order of the county board of supervisors. The settlement was made in January, 1930, following the termination of work on the high dam at the Forks site in the San Gabriel canyon that the site was unsuitable. In connection with the settlement, Sidney T. Graves, former chairman of the board of supervisors, was charged with accepting an $80,000 bribe and was convicted after a jury trial. He has filed an appeal, which still is pending.

Raw Water Service Proposed for Industries in Cleveland

An ordinance granting a 25-year franchise to the Water Utility Co. for the right to pipe raw water to industries along the Cuyahoga River valley in Cleveland was submitted to the city council on May 22. The ordinance would permit the company to construct a 12-ft. tunnel from the lake to factories located in the river bottom as far south as Clark Ave. S.W. The ordinance authorizes a charge of 1.5 cents per 1,000 gal for water supplied at lake level and 3 cents per 1,000 for water pumped to an elevation of over 50 ft.

The Cuyahoga Valley Waterworks, Inc., an affiliate of the Water Utility Co., has applied to the Reconstruction Finance Corp. for a loan of $3,000,000 to finance construction of the tunnel.

Personal Notes

GEORGE FLANDERS has been appointed city engineer of Portage, Wis., to succeed H. V. TENNANT.

ARTHUR T. COCHRANE, for the past 15 years an engineer with the Missouri Pacific Railroad, has been appointed chief building inspector for the city of St. Louis, Mo. Mr. Cochrane was in charge of building construction for the railroad.

EUGENE R. HOFFMAN has been appointed construction engineer of the state highway department, Seattle, Wash., a position he relinquished six years ago to become engineer for the Park Board of Seattle. Mr. Hoffman is a graduate of the University of Wisconsin.

PAUL W. MAETZEL has been named acting chief engineer of the engineering department, Columbus, Ohio, to succeed the late ROBERT H. SIMPSON. Mr. Maetzel has been engineer in charge of street construction since 1918.

TOM C. MCEWEN has been appointed district engineer in charge of the West Tennessee Division, Tennessee Highway Department, with headquarters at Jackson, Tenn., and W. N. REESE, former district engineer at Jackson, has been appointed construction engineer for the division.

J. DAVIS, of Falls City, Neb., has been appointed district engineer of the Missouri Pacific Lines at Little Rock, Ark., and E. SULLIVAN, of Pueblo, Colo., has been appointed district engineer at Kansas City. R. M. SMITH, division engineer at Coffeyville, Kan., will succeed Mr. Sullivan, and R. G. BUSH, of Kansas City, will succeed Mr. Smith.

MERTON R. KEEFE, formerly vice-president of Ulen & Co., Lebanon, Ind., has been appointed chief engineer of the Indiana Highway Commission. Fred Kellam, assistant chief engineer in charge of structures, has been acting as engineer since the dismissal of Wm. J. Titus on May 1. Mr. Keefe is a graduate of the civil engineering school of Purdue University in the class of 1902. He began his professional work on railroad construction and joined the firm of Ulen & Co. in 1909. Recently he was vice-president in charge of foreign construction.

Obituary

J. H. FREUND, president of the Federal Cement Tile Co., died at Chicago, Ill., May 22.

HARRY MCCURDY, for many years a superintendent on engineering construction work, died at his home in Ossining, N. Y., on May 26, age 68 years.

JOSEPH LAING, formerly a contractor on river, harbor and railroad work in the South and Southwestern part of the country, died at his home in Shreveport, La. on May 23, age 85 years.

J. FRANKLIN FULLER, a retired civil engineer, died at West Newton, Mass., May 25 at the age of 101. He was a native of Boston, and was formerly a

partner in the firm of Fuller & Whitney, engineers, of that city. An active part was played by Mr. Fuller in the construction of canals for the Niagara Falls Power Co. and in the development of that enterprise in the closing years of the last century.

Brief News

BIDS ON THE WATER DIVERSION PROJECT of the Twin Lakes Reservoir & Canal Co., Ordway, Colo., are expected to be called early in June. The work is being financed by the Reconstruction Finance Corp.

CONTRACT FOR THE RECONSTRUCTION of the La Fruita dam of the Corpus Christi, Texas, water system has been awarded to J. L. Simmons Construction Co. of Decatur, Ill. Work is being financed by the Reconstruction Finance Corp. The dam was badly damaged by a washout at one end of the spillway about three years ago.

A MORATORIUM ON IRRIGATION POWER charges has been declared by the department of public works of the state of Washington to provide immediate relief for farmers who are unable to pay for their power.

COMPLETION OF THE BOUNDARY SURVEY between Colorado and New Mexico, a boundary which has been the source of a long controversy, is provided for by the inclusion in the appropriation bill passed recently by the Colorado state legislature of an item of $8,000 to match a like appropriation by New Mexico.

CONSTRUCTION EQUIPMENT for a highway between Ciudad Victoria, the capital of Tamaulipas State and Reynosa on the American border in that state, has been exempted from import duties in order to speed up construction of the road. The federal government believes that completion will aid in Mexican exports to the United States.

RAPID PROGRESS is being made on the construction of a hydraulic fill for a highway across the marshes between Pass Rigolets and East Pearl River, in Louisiana. For many years it was thought possible to built a highway across the salt marshes bordering the Gulf of Mexico that lie between these two points. Completion of the highway will reduce the distance between New Orleans and the Mississippi Gulf coast by 24 miles.

PAYMENT OF WAGES as low as 15 cents an hour for common labor by contractors on street work in Indianapolis has resulted in an investigation by the board of public works and the issuance of formal notices by the board to contractors that they will be disqualified from further city work if they continue to pay wages below the minimum of 30 cents an hour established by the board more than a year ago.

A SUIT FOR $40,000 DAMAGES against the state highway department of Missouri brought by owners of a 580-acre farm near Clinton, Mo., has been decided in the state highway department's favor. The farm owners claim that the work done by the department to reduce flood damage along the Grand River in connection with the construction of state highway No. 13 has been detrimental rather than beneficial to their land.

Engineering Contracts and Capital

HEAVY engineering construction contracts reported for the past week total $17,960,000 a gain of 118 per cent over the previous week's total of $7,800,000. Private contract awards aggregated $15,027,000, the highest total reported for private work since July, 1932. A power plant in Philadelphia, $8,000,000, and a gas pipe line in Arizona, $1,200,000, accounted for most of the private total, though in addition industrial buildings exceeding $2,000,000, commercial buildings, $1,500,000 and about $2,000,000 in unclassified work helped to swell the private total. In contrast to the increase in private construction, public works awards sank to the low figure of $2,933,000, the next to lowest week of the year. While state and municipal awards amounted to only $2,816,000, one of the lowest totals of the year, a complete lack of federal awards was largely responsible for the poor showing made by public works. Federal awards were only $117,000, the lowest weekly figure on our records. Of the public works total, more than half was accounted for by highway lettings aggregating $1,865,000. New York state let road contracts in excess of a million dollars. The average of all contracts let the last four weeks is $10,516,000, as compared with a weekly average of $23,717,000 in June, 1932.

New productive capital figures for the week total $11,252,000. Leading the bond sales of the week was an issue of $4,677,000, sold by Westchester County, N. Y., for public improvements. The Southern Pacific Ry. borrowed $1,200,000 for the new passenger terminal at Houston.

Contracts and Capital

CONSTRUCTION
(Thousands of Dollars)

	Weekly June, 1932	Average Four Weeks	Week June 1, 1933
Federal government	$6,384	$586	$117
State and municipal	12,002	3,469	2,816
Total public	$18,386	$4,055	$2,933
Total private	5,331	6,461	15,027
Week's total	$23,717	$10,516	$17,960
Cumulative to date:			
1932		$503,245	
1933		359,390	

NEW PRODUCTIVE CAPITAL
(Thousands of Dollars)

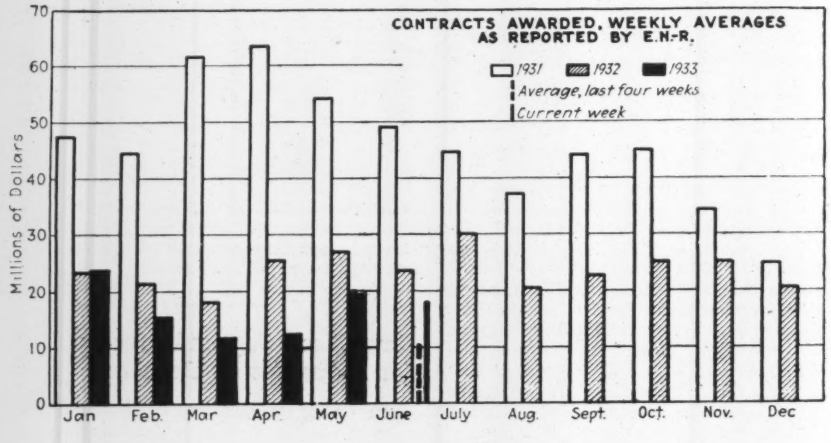
	Weekly May, 1932	Average Four Weeks	Week May 27, 1933
New capital issues	$18,000	$12,710	$11,252
Cumulative to date:			
1932		$367,000	
1933		125,620	

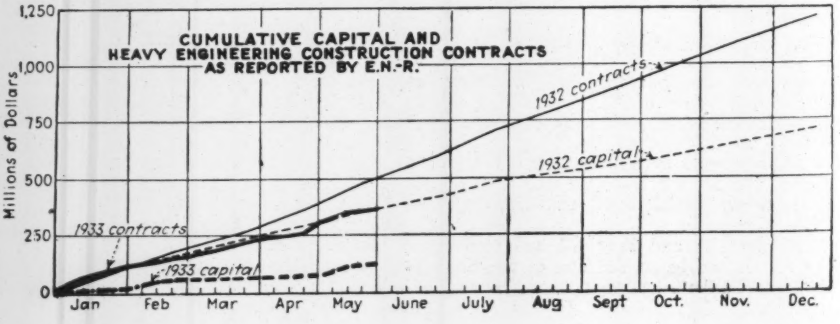
R.F.C. self-liquidating loans:

Approved current week	$773
Approved to date (including 1932)	206,440
Actual loans made (including 1932)	47,138

ENR Cost and Volume Index

E.N.-R. Cost		E.N.-R. Volume	
June, 1933	**163.41**	**May, 1933**	**103**
May, 1933	164.39	April, 1933	65
June, 1932	152.20	May, 1932	149
1932 (Average)	156.97	1932 (Average)	127
1931 (Average)	181.35	1931 (Average)	220
1930 (Average)	202.35	1930 (Average)	260
1913 Average	100		



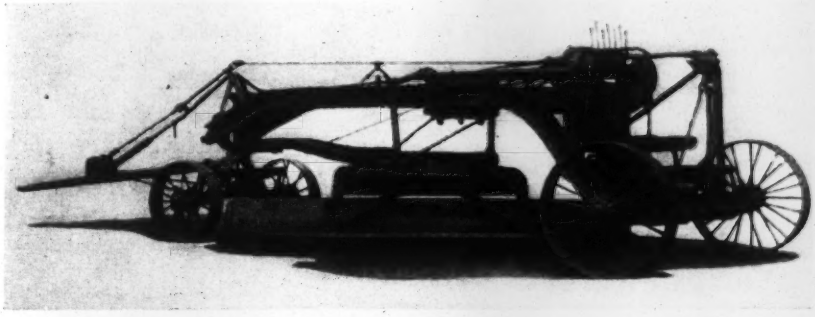


Construction Equipment and Materials

Power-Controlled Road Grader

The No. 66 "Caterpillar" grader with full power control is announced by the Caterpillar Tractor Co., Peoria, Ill. The control unit is the same as the one used on the Caterpillar 77 grader. A one-cylinder, air-cooled gasoline engine furnishes power to control 18 actions of the grader, including steering, leaning the wheels, raising and lowering the blade, turning and side shifting the circle, side shifting the rear axle and operating the scarifier. Seven power control levers, grouped in front of the operator, are equipped with automatic releases to protect the machine when the limit of any adjustment has been reached.

Aside from the power control, this grader is identical with the hand controlled No. 66 Caterpillar grader.



"Caterpillar 66" grader, with full power control.

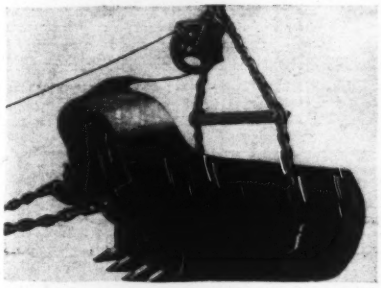
Rocker-Type Bucket For Dragline Excavator

The Page Engineering Co., Chicago, Ill., has announced the production of a new form of bucket for dragline excavation. The new bucket is called the "Page Rocker Bucket" and derives its name from its rocker-type hood. The company states that the hood has been redesigned so that the bucket will immediately rock backward and land on its teeth, without having to be lifted onto its teeth by a forward pull on the load line. Thus, the entire weight of the rocker bucket is on its teeth when it starts to dig.

The company states that the rocker-type bucket almost completely eliminates the forward projecting sides which have characterized former buckets and the attendant evils experienced when they were bent, due to the bucket having been dropped into the pit on its nose. By eliminating the forward extending sides, the need for heavy reinforcing has been dispensed with, resulting in a bucket of lighter weight with no sacrifice of strength. When lowered into the pit, the bucket strikes on its forward hood and immediately rolls into a digging position.

Another feature claimed for the bucket is that it digs as effectively in a deep pit as on the surface. The improved draft hitch makes the teeth bite into the earth regardless of the pit depth.

Page rocker bucket

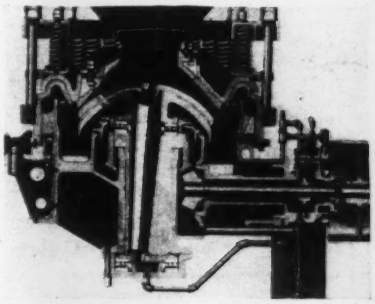


Secondary Crusher With Gyrating Head

Smith Engineering Works, Milwaukee, Wis., announces the Telsmith Gyrasphere, a spring release crusher, roller thrust bearings and choke feed. Its heavy steel hopper and large feed openings permit the machine to take a free gravity flow.

The crushing action is unique. All vertical thrust, constituting over half the load, is taken on the massive end-thrust bearings which are especially designed for heavy crushing duty. The horizontal crushing pressures transmitted to the eccentric bearings are reduced proportionately. Bell-mouthed eccentric sleeves are avoided.

Because of the spherical form of the head, the continuous flow of aggregate follows an arc-shaped course, which multiplies the number of pinches it receives.



Telsmith Gyrasphere by Smith Engineering Works.

Light-Weight Roller Can Be Hauled on Rubber-Tired Wheels

The Wheeled Roller Corp. of San Antonio, Tex. announces a new surface roller designed for the economical maintenance of highways and roads. It is a roller that can be hauled rapidly from one job to another on rubber-tired wheels. On the job it becomes a roller by the process of reversing the tongue by lifting it up and over, thereby bringing the roller surface in contact with the ground. An eccentric axle construction raises the wheels out of the way.

By reversing the tongue, the roller can be brought into contact with the ground.

The roller has a width of 36 in. and a weight of about 100 lb. per contact inch. It is possible to add sand or dirt inside the roller drum through plates placed at the end to increase the weight to about 170 lb. per contact-inch of roller.

New Equipment in Brief

Rivetless Chains. The Jeffrey Mfg. Co., Columbus, Ohio, announces the Jeffrey triple "E" rivetless chain for conveyor service. The links of the chain are connected by drop forged pins having T-shaped heads for locking in the side bars.

Pipe-Joint Packing. A loosely braided cotton cord for use in packing joints in bell-and-spigot cast-iron pipe instead of the twisted jute cord usually used for this purpose has been developed by C. A. Jones of the Georgia School of Technology, Atlanta, Ga.

Steel Joists. Bethlehem Steel Co. has announced the addition of four new minimum weights of Bethlehem joists and one new stanchion section to the line of Bethlehem structural shapes. The four new minimum weights of joists are as follows: Section BJ12, 12 in. x 14 lb. per foot; section BJ10, 10 in. x 11½ lb. per foot; section BJ8, 8 in. x 10 lb. per foot; section BJ6, 6 in. x 8½ lb. per foot. The new stanchion is designated as BS4 and is 4x4 in., in weights of 7½, 10 and 13 lb. per foot.

Road Grader. The Austin-Western Road Machinery Co., 400 North Michigan Ave., Chicago, Ill., announces the Austin Model 77 Motor Grader. It is powered with a 6 cylinder motor that develops 53 hp. There are six speeds forward, ranging from 1.39 to 13 m.p.h. Four drive wheels grip the road surface to provide freedom from wheel slippage and miring. Eighty in. wide front axle resists side draft, and, according to the company, increases stability and makes the machine easier to handle. This grader can be furnished with either hand or hydraulic power control; the dual drive motor grader can be furnished with a diesel motor.

Business Side of Construction

Western Bridge Contracts Raise May Construction Volume

AWARD OF THE MAJOR construction contracts for the San Francisco-Oakland bridge, coupled with the simultaneous award of several tunnel contracts on the Colorado River aqueduct, raised the contract total reported the first week of May to $54,000,000, the highest weekly figure reported since November 1931, and pushed the May total of contracts to $78,198,000, or an average of $19,500,000 per week. The May construction volume registered a gain of over 50 per cent over the 12.4 million dollar average of April. The weekly average of contracts reported in May, 1932, was 26.9 millions. The gain on the May volume was due entirely to public works, as the private construction average dropped to 4.4 millions per week from the April average of public millions. The May average of public works awards is 15.1 millions per week as compared with the April average of 6.7 million.

Materials continue rise

The upward trend of construction materials prices continued during May. The upturn in lumber prices, noted in April, spread throughout the country during May. One of the sharpest increases noted during the month was that of hydrated finishing lime, which advanced $3.50 per ton in most localities. Lime producers state that the price of this commodity has been below cost for the past year and that the increased price puts this commodity on a small profit basis, when and if any tonnage develops.

Materials notes

Cement—Some increased activity is noted in the cement industry. The Salt Lake plant of the Portland Cement Company in Utah, closed since last November, was opened recently on a 24-hour basis.

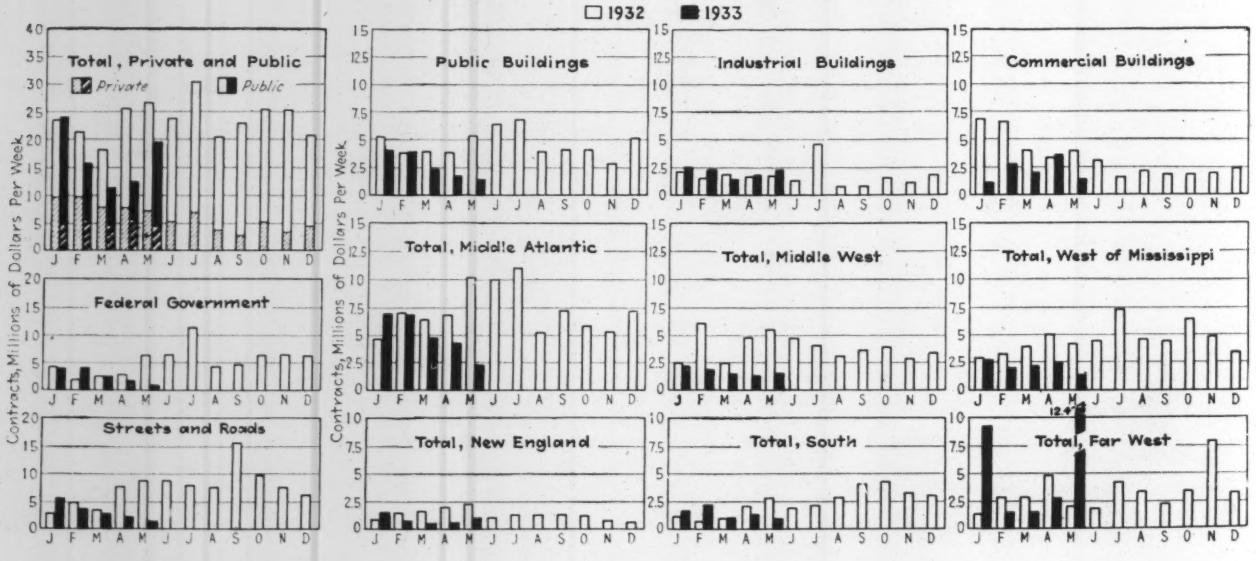
The Portland cement industry in April, 1933, produced 4,183,000 barrels; gypsum, 4,929,000 barrels from the mills and had in stock at the end of the month 20,532,000 barrels. Production showed a decrease of 24.3 per cent as compared with April, 1932. Portland cement stocks at the mills were 22.5 per cent lower than a year ago, according to the U. S. Bureau of Mines. The April production in relation to capacity is rated at 18.9 per cent, as compared with 24.0 per cent a year ago. The production in March of this year was rated at 16.1 per cent. Production for the 12 months ending April, 1933, was 26.2 per cent of capacity, as compared with 41.7 per cent for the same period a year ago.

Lumber — The lumber business continued to improve during May, new orders booked each week being larger

ENGINEERING CONSTRUCTION CONTRACTS REPORTED IN MAY, 1933

Four Weeks—Thousands of Dollars (000 omitted)

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States May 1933	United States Five Months 1933	United States Five Months 1932	Canada May, 1933
Public Works										
Waterworks	16	209	140	124	182	8,043	8,714	39,813	11,200	....
Sewers	107	193	244	148	485	17	1,194	7,088	11,434	38
Bridges, public	15	41	97	232	58	37,094	37,537	48,000	20,746	395
Earthwork and waterways	170	43	63	102	25	77	480	20,411	24,587	....
Streets and roads	1,028	1,072	710	829	1,697	914	6,250	63,891	113,800	66
Buildings, public	262	898	1,249	1,395	89	719	5,416	54,881	91,535	....
Unclassified, public	110	256	51	97	.....	340	854	3,810	26,272	15
Total public	1,708	2,712	2,554	2,927	3,340	47,204	60,445	237,894	299,574	514
Federal gov't. (included in above classifications)	85	294	1,425	525	534	156	3,019	52,133	73,582	....
Private										
Bridges, private	.....	161	.....	.....	.....	.....	161	3,142	1,603	....
Buildings, industrial	1,527	2,565	1,404	1,717	355	1,477	9,045	42,824	38,425	80
Buildings, commercial	690	3,905	145	190	443	220	5,593	42,490	102,176	1,000
Unclassified, private	85	180	17	1,600	520	552	2,954	15,080	37,750	.....
Total private	2,302	6,811	1,566	3,507	1,318	2,249	17,753	103,536	179,954	1,080
May, 1933 (4 weeks)	**4,010**	**9,523**	**4,120**	**6,434**	**4,658**	**49,453**	**78,198**	.....	.....	**1,594**
April, 1933 (4 weeks)	2,400	16,747	5,571	5,243	9,052	10,378	49,393	.....	.....	5,666
May, 1932 (4 weeks)	9,201	40,420	10,889	22,231	16,962	8,040	107,743	.....	.....	5,605
Five months, 1933	17,587	103,473	31,389	35,960	43,365	109,656	.....	341,430	.....	9,889
Five months, 1932	37,716	171,636	32,397	91,069	83,056	63,654	.....	.....	479,528	20,190



than for the previous week, according to the National Lumber Manufactures Assn. Business booked during the first week of the month was the largest so far this year, and exceeded any week of 1932 except two. By the second week of the month orders had exceeded any of this year or last, exceeding 200,000,000,000 board-feet. This figure was again exceeded the following week, with new business totaling 224,111,000,000 board-feet. Production was stepped up as new orders came in, though the industry is still following the policy of keeping production below shipments in order to reduce stocks.

The lumber production in 1932 was approximately 9,500,000,000 board-feet, according to a preliminary report of identical mills just released by the U. S. Census Bureau. This compares with 36,886,000,000 feet in 1929.

Steel—The current increase in steel production is one of the bright spots of the business situation. At the end of March production of steel ingots was rated at 15 per cent of capacity. During April the production had increased to 29 per cent of capacity. During the last week in May production had risen to 43 per cent of capacity, a rate expected to hold until at least July, when the summer recession is looked for.

Structural prices so far have remained firm. Increases were noted during the month in sheets and scrap. Steel men are of the opinion that any marked increase in buying will cause structural prices to rise. Basic structural prices at Pittsburgh have remained $1.60 since the middle of last year, when a 10-cent increase went into effect.

The American Iron & Steel Institute reports that steel ingot production for April was 1,334,797 tons, or an average of 24.56 per cent of capacity. The March output is estimated at 891,000 tons. The American Institute of Steel Construction reports that structural steel tonnage booked in April was 45,167 tons, and shipments amounted to 47,822 tons. Both these figures are under the average of the first quarter of this year and the 1932 monthly average.

Labor notes

Montreal—The city revised a contract awarded for ten miles of 36-in. pipe, originally $1,220,915, to provide for hand labor excavation of the trench. The revision will give work to 400 more men and provide 1,120,000 additional man-hours of employment but will increase the cost of the excavation $413,000, which will be paid by the city.

Detroit—Labor troubles between the International Longshoremen's Union and the Dredge Owners Association brought to a standstill river and harbor work on projects in the Detroit district. Approximately 1,000 men are deprived of employment as a result of this disagreement.

Massachusetts — Highway construction in Massachusetts during April provided employment for an average of 1,872 men, as compared with 1,483 for March. The average wages paid per week in April per man was $21.50, as compared with $25.14 for March.

New York—Then index number of employment in New York State, based on the number of applications for every 100 positions offered by employers, was the lowest of the year in April, standing at 428.6, as compared with 584.3 for March, 545.8 for February, and 580.6 for January.

CURRENT BUILDING AND CONSTRUCTION TRADES WAGE RATES PER HOUR

Cities	Bricklayers	Carpenters	Hoisting Engineers	Pile Drivers	Structural Iron Workers	Masons' Laborers	Common Laborers
Atlanta	$0.75@1.12½	$0.40@.90	$0.60@1.25	.....	$0.60@1.25	$0.25	$0.20@.25
Baltimore	1.00	.90	1.00@1.37½	$0.65	1.00@1.25	.40	.30
Birmingham	.75@.87½	.60	.75	.....	.75	.25	.20@.30
Boston	.90@1.30	.60@1.17½	.90@1.17½	.70@1.07½	1.00@1.20	.45@.70	.35@.70
Cincinnati	1.27½	1.02½	1.07½	1.07½	1.20	.70	.40@.45
Chicago	1.37½	1.31¼	1.31¼	1.31¼	1.35	.88¾	.82½
Cleveland	.90@1.37½	.75@1.12½	.90@1.12½	1.00	.90@1.06¼	.56¼	.30@.72
Dallas	.62½	.50	.50	.50	.50	.25	.25@.35
Denver	1.00@1.12½	.75@.87½	.75@.87½	.....	.75@.87½	.50	.31¼@.50
Detroit	.75@1.50	.55@.80	1.25	1.25	1.25	.70	.30@.50
Kansas City	1.30	1.00	1.06	1.06	1.00	.70	.35@.60
Los Angeles	.62½	.50	.75	.75	.75	.50@.62½	.40@.50
Minneapolis	.90@1.00	.75	.75	.....	.90	.50	.40@.50
New Orleans	1.00	.75	1.00	.70	1.25	.25@.40	.15@.25
New York	1.50@1.65	1.25@1.40	1.50@1.65	1.50	1.65	.81¼@1.00	.50@.75
Philadelphia	.75@1.00	.50@.75	.75@1.00	.60@.75	.75@1.00	.20@.35	.20@.30
Pittsburgh	.60@1.50	.60@1.25	.60@1.37½	1.00@1.18¾	.60@1.37½	.50	.40@.70
St. Louis	1.50	1.25	1.35@1.47	1.25	1.47	1.00	.35@.78¾
San Francisco	1.12½	.90	1.00	1.00	1.20	.75	.65
Seattle	.75@1.20	.50@.90	1.00	.90	1.10	.66	.40@.50
Montreal	.75	.60	.55	.....	.70	.45	.25@.30

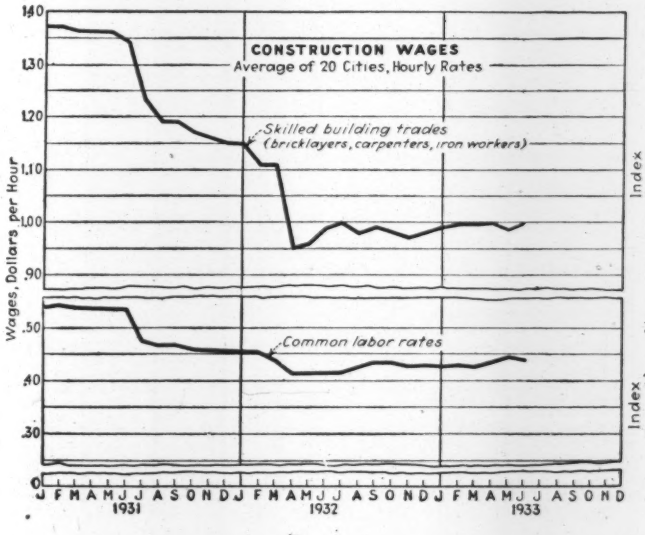
Skilled Average (3 trades) $0.994 Common Average, $0.439

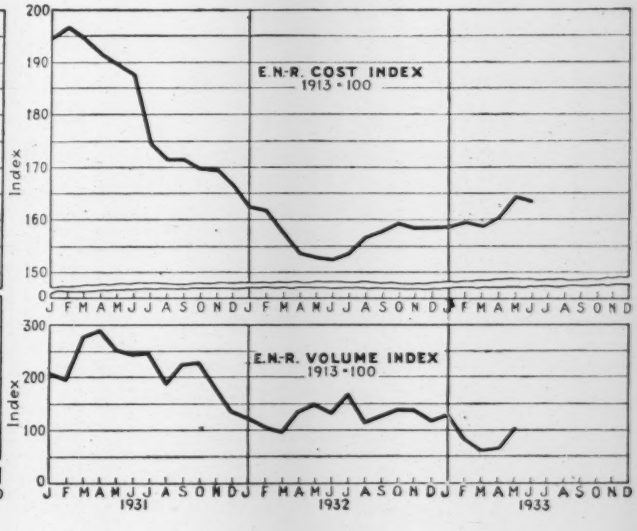
ENR Cost and Volume Index

The *Engineering News-Record* construction cost index for June is 163.41, a slight decline from the year's high figure of 164.39 in May. The decline in the index this month is due entirely to a slight lowering of average of common construction wages paid throughout the United States. The basic commodity prices, steel, lumber and cement, used in the compilation of the index, remain the same as for May. A year ago the cost index was at the lowest point in 16 years, 152.20. The *Engineering News-Record* construction volume index for May is 103, the highest in four months. Last year the May volume index was 149.

E.N.-R. Cost		E.N.-R. Volume	
June, 1933	**163.41**	**May, 1933**	**103**
May, 1933	164.39	April, 1933	65
June, 1932	152.20	May, 1932	149
1932 (Average)	156.97	1932 (Average)	127
1931 (Average)	181.35	1931 (Average)	220
1930 (Average)	202.35	1930 (Average)	260

1913 Average..... 100




E.N.-R. COST INDEX
1913 = 100
Index
200
190
180
170
160
150
0
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
E.N.-R. VOLUME INDEX
1913 = 100
Index
300
200
100
0
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1931
1932
1933

Current Prices of Construction Materials

Building Materials

PORTLAND CEMENT — Prices are for carload lots. For cement in returnable cloth bags add 40c. per bbl.; in non-returnable paper bags add 15c. per bbl., to following net prices:

	F.o.b.	Delivered		F.o.b.	Delivered
Atlanta	$2.38	$2.95	Kansas City	$1.75	$1.85
Baltimore	....	2.03	Los Angeles	2.10	....
Birmingham	2.00	2.10	Minneapolis	2.20	2.35
Boston	1.92	2.12	Montreal	1.70	....
Chicago	1.60	1.95	New Orleans	1.90	2.20
Cincinnati	2.31	2.46	New York	1.88	2.20
Cleveland	1.77	2.00	Philadelphia	1.94	2.04
Dallas	2.30	2.45	Pittsburgh	1.87	2.32
Denver	2.65	2.81	St. Louis	1.74	2.15
Detroit	1.90	2.05	San Francisco	2.05	....
			Seattle	2.55	2.70

Current mill-prices per barrel to dealers, for carloads of 132 barrels or over, without including charge for four bags, f.o.b. Bag charges same as in preceding table:

Alpena, Mich	$1.40	Mason City, Ia	$1.45
Buffington, Ind	1.35	Norfolk, Va	1.61
Dallas, Tex. (Inc. 5c. tax)	1.80	Northampton, Pa	1.40
Hannibal, Mo	1.35	North Birmingham, Ala	1.60
Hudson, N. Y	1.50	Richard City, Tenn	1.70
Independence, Kan	1.45	Saginaw, Mich	1.25
Ironton, Ohio	1.35	Steelton, Minn	1.55
Iola, Kan	1.45	Universal, Pa	1.40
La Salle, Ill	1.35	Waco, Tex	1.75
Limedale, Ind	1.35	Wyandotte, Mich	1.30

SAND AND GRAVEL — Per ton, carload lots, gravel, size ¾-in.:

	Gravel		Sand	
	F.o.b.	Delivered	F.o.b.	Delivered
Atlanta	$2.20	$2.25	$1.50	$1.90
Baltimore	....	2.55	....	2.08
Birmingham, per cu.yd	....	3.00	....	2.40
Boston	1.40	1.65	.90	1.15
Chicago, per cu.yd	....	2.25	....	2.25
Cincinnati	1.20	1.65	.95	1.40
Cleveland	....	2.00	1.40	2.00
Dallas, per cu.yd	1.40	2.40	1.65	2.40
Denver, per cu.yd	1.75	....	1.15	....
Detroit	.50	1.45	.72	1.50
Kansas City (at plant)	.65	....	.50	....
Los Angeles	1.45	1.60	1.00	1.10
Minneapolis	....	1.60	....	.75
New Orleans	1.40	2.40*	1.20	2.00*
New York, per cu.yd	1.50	3.50	1.00	2.25
Philadelphia	....	1.85	....	1.52
Pittsburgh	....	1.20	....	1.40
St. Louis	.80	1.40	.60	1.25
San Francisco	1.65	....	1.65	....
Seattle, per cu.yd	1.75	....	1.75	....

*Cu.yd.

CRUSHED STONE — Per ton, size 1½-in., carload lots, limestone:

	F.o.b.	Delivered
Atlanta	$1.95	$2.00
Baltimore	....	2.60
Birmingham	.80	1.05
Boston	1.40	1.65
Chicago, per cu.yd, 2,500 lb	....	2.25
Cincinnati	1.65	1.85
Cleveland	....	2.00
Dallas, per cu.yd., 2,500 lb	1.65	3.00
Denver, granite, per cu.yd., 2,700 lb	....	2.50
Detroit	....	1.75
Kansas City (at plant)	1.00	....
Los Angeles	1.45	1.60
Minneapolis	....	1.60
New York, per cu.yd., 2,800@3,000 lb	1.65	3.25
Philadelphia	....	2.20
Pittsburgh	....	2.25
St. Louis	1.35	1.65
San Francisco, trap rock	....	1.65
Seattle, per cu.yd., 3,000 lb	1.10	....

CRUSHED SLAG—Prices for carloads, per net ton, at plant:

	1½-In.	¾-In.	Roofing	Slag Sand
Birmingham	$0.90	$1.15	$2.05	$0.55
Buffalo	1.35	1.35	1.85	1.25
Cleveland	1.70	1.70	....	1.35
Toledo	1.20	1.20	1.20	1.10
Western Pennsylvania	1.25	1.25	2.00	1.25
Youngstown	1.10	1.20	2.00	.75

CONCRETE BLOCKS—Standard, 8x8x16-in., hollow, delivered to job, each:

Baltimore (8x12x12)	$0.20	Kansas City	$0.18
Birmingham (5x8x12)	.084	Los Angeles	.125
Boston	.14	Minneapolis	.10
Brooklyn and Queens	.09	Montreal	.12
Chicago	.175	New Orleans	.16
Cleveland	.165	Philadelphia	.15
Denver	.15	Pittsburgh	.18
Detroit	.09	St. Louis	.14

READY MIXED CONCRETE—Per cu.yd., 1:2:4, delivered 50 cu.yd. or more:

Atlanta	$7.75	Los Angeles	$6.10
Birmingham	5.00	Minneapolis	6.00
Boston	6.00	New Orleans	6.05
Cleveland	6.20	New York (Manhattan)	8.50
Cincinnati	5.95	Philadelphia	5.98
Dallas	7.00	Pittsburgh	6.05
Detroit 1:2½:5	4.75	St. Louis	6.50@6.30
Kansas City	7.50	Seattle	5.35

HOLLOW TILE—Building tile per block, delivered to contractors in lots o 2,000 pieces or over:

	4x12x12	6x12x12	8x12x12	10x12x12	12x12x12
Atlanta	$0.09	$0.11	$0.13	$0.20	$0.25
Baltimore	.10	.14	.20	.22	.30
Birmingham	.089	.122	.167	.219	.25
Boston	.0775	.1065	.1453	.1799	.208
Chicago	.0484	.063	.09	.1179	.13
Cincinnati	.06815	....	....	.165	....
Cleveland	.048	.066	.09	.117	.13
Dallas	.0455	....	....	.117	....
Denver	.085	.135	.175	.19	.25
Detroit	.0505	.065	.0947	.1175	.1305
Kansas City	.0735	.092	.15	.1777	.20725
Los Angeles	.085	....	....	.22	....
Minneapolis	.0692	.0988	.1372	.1447	.2029
New Orleans	.08	....	....	.22	....
New York	.076	.118	.147	....	....
Perth Amboy	....	....	....	.2388*	.2956*
Philadelphia	.065	.093	.14	.175	.195
Pittsburgh	.0435	.065	.088	.1165	.126
St. Louis	.058	.082	.112	.155	.19
San Francisco	.0765	.105	.1765	....	....
Seattle	.085	.115	.18	....	....

*At plant. (Load-bearing tile).

BRICK — Prices per thousand in carload lots, as follows:

	Common Backing		Paving
	F.o.b.	Delivered	F.o.b. 3x8½x4-in.
Atlanta	$8.50	$10.00	$32.00
Baltimore	....	12.00	43.00†
Birmingham	10.00	12.50	25.00
Boston	11.50	13.00	30.00
Chicago	....	9.00	32.00
Cincinnati	13.50	16.00	36.50
Cleveland	12.00	14.00	33.00
Dallas	8.50	10.00	25.00†
Denver	13.00	....	40.00
Detroit	....	11.50	35.25
Kansas City	....	12.00	35.00
Los Angeles	8.50	10.50	....
Minneapolis	....	7.50	....
Montreal	21.25	....	....
New Orleans	11.00	14.00	40.00
New York	9.50	12.50	45.00
Philadelphia	....	13.00	40.00
Pittsburgh	11.00	13.00	35.00
St. Louis	....	11.00	32.50†
San Francisco	....	14.00	45.00*
Seattle	12.00	14.00	....

*2½x8½x4 in. †3½x8½x4 in.

LIME — Prices of hydrated, per ton, in paper; lump, per 180-lb. bbl., net:

	Hydrated — Finishing		Hydrated — Common		Common Lump,	
	F.o.b.	Delivered	F.o.b.	Delivered	F.o.b.	Delivered
Atlanta	$17.00	$21.50	$11.50	$14.00	....	$2.50
Baltimore	....	23.50	....	13.00	....	....
Birmingham	21.00	....	12.00	....	$1.65	....
Boston	16.00	18.50	11.50	14.00	2.00*	2.75*
Chicago	....	20.00	....	14.00	....	2.75
Cincinnati	13.50	14.50	8.65	9.65	....	....
Cleveland	14.00	17.50	8.50	12.00	....	2.50
Dallas	....	20.00	....	....	....	2.75
Denver	....	30.00	....	22.00	....	2.85*
Detroit	12.75	17.50	7.25	12.00	....	....
Kansas City	.475‡	.50‡	....	.50‡	....	2.75
Los Angeles	....	22.00	....	19.00	....	2.00
Minneapolis	....	21.00	....	19.00	....	1.70
Montreal	....	....	12.00	13.00	....	....
New Orleans	17.00	24.50	10.00	13.00	1.66	1.95
New York	14.20	18.00	9.45	13.00	2.25*	3.15*
Philadelphia	14.00	18.89	9.90	13.49	....	1.18
Pittsburgh	14.20	15.70	9.95	11.45	1.85	2.35
St. Louis	....	.45‡	....	.40‡	....	2.75
San Francisco	22.50	....	19.00	....	1.59	....
Seattle	....	32.00	....	24.00	....	2.80

*Per 280-lb. bbl. (net.) ‡Per sack.

LIMESTONE—Mill blocks, f.o.b. siding, per cu.ft.:
New York:* Rustic buff, $1.38; Standard gray, $1.48; Standard buff, $1.58; Selected gray, $1.58; Selected buff, $1.68; Variegated, $1.38.
Boston: Rustic buff, $1.47; Standard, $1.57; Selected buff, $1.67.
Pittsburgh: Rustic buff, $1.14; Standard, $1.24 at quarry; Selected buff, $1.34.
Philadelphia: Sel. buff, $1.59; Sel. gray, $1.49; Standard, $1.49; Standard gray, $1.39; Rustic buff, $1.39.
Atlanta: Standard $1.26.
*F.o.b. Bedford, freight allowed to N. Y.

SLATE—Roofing, f.o.b. quarry, Bangor, Pa., net, per square;

No. 1 Clear	$8.25@$9.50
No. 1 Ribbon	6.75@ 7.50
Medium Clear	7.25@ 8.00

Road and Paving Materials

PAVING STONE — Granite, lots of 50,000 blocks, 4x8x4-in., dressed, f.o.b. city:

Atlanta	$3.00 per sq.yd.
Baltimore	43.00 per M.
Birmingham (3½x8½x4-in.)	76.25 per M.
Boston	75.00 per M.
Chicago, 5 in	3.80 per sq.yd.
Cincinnati	110.00 per M.
Cleveland	96.00 per M.
Dallas	25.00 per M.
Detroit, 5 in	2.80 per sq.yd.
Kansas City	2.75 per sq.yd
Minneapolis, 4½ in	2.80 per sq.yd‡
Montreal	104.75 per M.
New Orleans	2.80 per sq.yd.
New York, 5 in	135.00 per M.
Philadelphia, 4x10x5	115.00 per M.
Pittsburgh	115.00 per M.
St. Louis, 5 in	2.80 per sq.yd.

Current Prices of Construction Materials

Road and Paving Materials—Continued

WOOD-BLOCK PAVING — Prices f.o.b., in carload lots:

	Size of Block	Treatment	Per Sq.Yd.
Atlanta	3½	16	$2.25
Boston	3½	16	2.00
Chicago	3½	12	1.90
Kansas City	3½	16	2.50
Minneapolis	2½	8	1.65
Montreal	3½	16	2.63
New York	3½	14	1.90
Philadelphia	3½	16	2.02
St. Louis	3½	16	2.00

CURBING—Per lin.ft., 5x16 in., straight, rough, f.o.b., in carload lots:

Atlanta	$0.41	Kansas City	$0.60
Birmingham	.50	New York	.65
Boston	.60	Philadelphia (6x20 dressed)	1.40
Dallas	.60	Pittsburgh	.80
Detroit	.45	St. Louis	.70

ASPHALT—Paving asphalt, f.o.b., per ton. Packages are 350-lb. bbl. or 425-lb. drums, in carload lots:

	Packages	Tank-car or -boat
Atlanta	$21.60	$17.40
Baltimore	19.00	15.00
Birmingham	.....	11.00
Boston	20.00	16.00
Chicago	22.50	15.50
Cincinnati (f.o.b. refinery)	18.00	14.00
Cleveland	18.00	14.00
Dallas	.....	27.00
Denver	27.50	.....
Detroit	16.80	12.43
Kansas City (f.o.b. refinery)	17.00	12.00
Los Angeles	16.50	10.50
Maurer, N. J. (Bermudez)	.....	26.00
Maurer, N. J. (Trinidad)	.....	22.00
Minneapolis (f.o.b. Twin Cities)	23.30	18.30
Montreal (f.o.b. factory)	18.66	13.00
New Orleans	17.00	13.00
New York	19.00	15.00
Philadelphia	17.00	11.00
Pittsburgh	25.00	16.00
St. Louis	21.70	17.70
San Francisco (f.o.b. refinery)	16.00	10.00
Seattle	21.10	16.00

LIQUID ASPHALT — Residual, hot application, f.o.b., in tank cars, 8,000 gal. minimum, per gal.:

Atlanta	$0.0689
Baltimore	.06
Birmingham	.06
Boston	.06
Cincinnati	.075
Dallas	.05
Kansas City	.05
Los Angeles	.05
Montreal at (refinery)	.09
New York	.06
Philadelphia	.08
Pittsburgh	.05
St. Louis	.07

EMULSIFIED ASPHALT — For penetration and surface treatment, per gal.:

Boston, applied	$0.13
Cincinnati, f.o.b. refinery	.06
Los Angeles, applied	.13
Des Moines, applied	.14
New York, applied	.15
Philadelphia, applied	.15
St. Louis, applied	.13
Seattle, f.o.b. refinery	.08

Iron and Steel

	Pittsburgh	Chicago	Birmingham
STRUCTURAL SHAPES AND PLATES, per 100 lb., base, carload lots	$1.60	$1.70	$1.75
CONCRETE REINFORCING BARS, ½ in., billet, per 100 lb., carload lots	1.55	1.65	1.75
SHEETS, per 100 lb., carload lots:			
Hot-rolled No. 10	1.45	1.65	1.65
Hot-rolled annealed No. 24	2.05	2.30	2.25
Galvanized No. 24	2.70	2.74	2.85
RIVETS per 100 lb., ½ in., structural, carload lots	2.25	2.35	2.30
SHEETPILING, per 100 lb., base, carload lots	1.90	2.05	.....
WIRE NAILS, per 100 lb., base, carload lots	1.85	2.05	2.30
HEAVY MELTING STEEL SCRAP, No. 1, per gross ton, at consuming point	11.50@12.00	6.75	7@7.50

TRIANGLE MESH—Plain, per 100 sq.ft., in carload lots:

Style Number	Size, In.	Weight in Pounds Per 100 Sq.Ft.	Pittsburgh Mill	Chicago District Mill
032	4x4	22	$0.85	$0.86
049	4x4	28	1.07	1.10
068	4x4	35	1.30	1.34
093	4x4	45	1.68	1.72
126	4x4	57	2.08	2.13
153	4x4	68	2.47	2.54
180	4x4	78	2.84	2.92
245	4x4	103	3.75	3.84
287	4x4	119	4.34	4.35
336	4x4	138	5.03	5.16
395	4x4	160	5.83	5.98
036P	4x8	17	.64	.66
053P	4x8	24	.91	.93

TRIANGLE MESH—*Continued*

Style Number	Size, In.	Weight in Pounds Per 100 Sq.Ft.	Pittsburgh Mill	Chicago District Mill
072P	4x8	31	1.14	1.17
097P	4x8	40	1.48	1.51
049R	4x8	24	.91	.93
067R	4x8	31	1.14	1.17
089R	4x8	40	1.48	1.51

WIRE ROPE—Discounts from manufacturers' list prices on regular grades of bright and galvanized, Eastern Territory, New York, and East of Missouri River:

	Base
Cast steel round strand rope	25 %
Galvanized iron rigging and guy rope (add to list)	7½ %
Galvanized steel rigging and guy rope	12½ %
Plow steel round strand rope	40 %
"Special Steel" and extra strong cast steel, round strand rope	32½ %

Discount 5 points less than discount for Eastern territory: California, Colorado, Kansas, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, Texas, Washington and Wyoming. Discount 10 points less than discount for Eastern territory: Arizona, Idaho, Montana and Utah.

EXPANDED METAL LATH—Per 100 sq.yd., painted, f.o.b., in carload lots 2.2 lb. per sq.yd., standard-mesh diamond lath:

Atlanta	$15.00	Los Angeles	$17.00
Birmingham	17.00	Montreal (2.5 lb.)	24.00
Boston	15.00	New Orleans	20.00
Chicago	10.60	New York	13.50
Cincinnati	11.00	Philadelphia	13.50
Dallas	16.00	Pittsburgh	13.50
Detroit	18.00*	St. Louis	19.00*
Kansas City	17.00*	San Francisco	17.00*
*Delivered.		Seattle	17.00

STEEL FREIGHT RATES — Per 100 lb., effective Dec. 3, 1931, on finished steel products in the Pittsburgh District, including plates, structural shapes, merchant-steel bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc.; 40,000 lb. per car:

Atlanta, 36,000 lb.	$0.60	Detroit	$0.285
Baltimore	.29	Kansas City	.59
Birmingham	.60	New Orleans, 36,000 lb.	.69
Boston	.42	New York, 40,000 lb.	.35
Buffalo	.255	Pacific Coast, 60,000 lb.	1.17*
Chicago	.36	Philadelphia	.31
Cincinnati	.285	St. Louis	.41
Cleveland	.205	St. Paul	.60
Denver	.92	* All rail.	

Railway Materials and Supplies

STEEL RAILS — Per gross ton, f.o.b.

	Pittsburgh	Birmingham	Chicago
Standard rails	$40.00	$40.00	$40.00
Light rails	30.00	30.00	30.00
Re-rolled rails	26.00	.....	27.00

RAILWAY TIES — Prices f.o.b., per tie, for carload lots:

		6 In. x 8 In. by 8 Ft.	7 In. x 9 In. by 8½ Ft.
Boston	Oak, untreated	$0.90	.....
	Pine, untreated	.85	.....
	Pine, creosoted	1.40	.....
New York	Long-leaf sap pine, untreated	.80	$1.00
	Mixed oak, untreated	....	1.00
Birmingham	White oak, untreated	.75	.95
	White oak, creosoted	1.35	1.45
	Southern pine, untreated	.35	.80
	Southern pine, creosoted	.95	1.35
Chicago	White oak, untreated	1.05	1.35
	Oak, empty cell, creosoted	1.40	1.80
	Oak, zinc treated	1.25	1.65
	Southern pine, creosoted	1.15	1.50
Los Angeles	Fir, untreated	.45	....
	Fir, creosoted	1.15	....
Philadelphia	Red oak, untreated	.95	1.15
	Red oak, creosoted	1.47	1.90
St. Louis	White oak, untreated	.85	1.30
	Red oak, untreated	.75	1.20
	Red oak, creosoted	1.12	1.70
	Sap pine or cypress, untreated	.65	1.00
San Francisco	Douglas fir, green, untreated	.45	.63
	Douglas fir, empty cell, creosoted	1.14	1.56
Montreal	Birch or maple, untreated	1.00	1.00
	Birch or maple, creosoted	1.25	1.55

TRACK SUPPLIES — Prices per 100 lb., f.o.b., for carload lots:

	Pittsburgh	Birmingham	Chicago
Angle bars	$2.55	$2.55	$2.75
Standard spikes	2.15	2.15	2.60
Tie plates	1.75	1.85	1.85
Track bolts	3.50	3.50	3.50

Pipe

WROUGHT STEEL PIPE — Discounts from standard list for delivery from warehouse, except at Pittsburgh, where prices are f.o.b. mill. List prices per ft. as follows: 1-in., 17c.; 3-in., 76½c.; 3½-in., 92c.; 6-in., $1.92.

	1 to 3-In. Butt Weld		2½ to 6-In. Lap Weld	
	Black	Galvanized	Black	Galvanized
Atlanta	52%	44.5%	50%	42%
Chicago	57.25%	44.71%	53.83%	41.29%
Cleveland	53.3%	42.3%	50.8%	37.8%
New York	56.14%	43.6%	52.72%	40.18%
Philadelphia	57.28%	44.68%	53.68%	41.80%
Pittsburgh	71%	62%	69½%	60½%
St. Louis	60.64%	49.84%	58.84%	48.04%

Current Prices of Construction Materials

Pipe—Continued

CAST-IRON PIPE— Prices per net ton, for bell and spigot pipe, Class B and heavier, f.o.b. in carload lots; gas pipe and Class A, $3.00 per ton extra:

	4-In.	6-In. and Over
Atlanta	$37.50	$34.50
Boston	41.00	38.00
Birmingham (Base)	33.00	30.00
Burlington (Base)	35.00	32.00
Chicago	41.50	38.50
Dallas	45.50	42.50
Los Angeles	41.50	38.50
New York	38.50	35.50
Philadelphia (rail delivery)	36.50	33.50
Pittsburgh	41.50	38.50
St. Louis	40.50	37.50
San Francisco	41.50	38.50

SEWER PIPE—Prices delivered, per foot, for standard pipe; 6, 8 and 12-in. are single strength and 18, 24, 30 and 36-in. are double strength:

	6-In.	8-In.	12-In.	18-In.	24-In.	30-In.	36-In.
Atlanta	$0.135	$0.21	$0.385	.....	$1.40	.....	.....
Baltimore	.10	.30	.58	.....	1.93	.....	$6.50
Birmingham	.18	.30	.54	$1.02	1.95	$3.50	5.00
Boston	.135	.21	.405	1.325	2.385	4.68	7.175
Chicago	.18	.28	.54	1.25	2.25	4.75	6.00
Cincinnati	.0945	.....	.2835	.....	1.125	2.448	.....
Cleveland	.1575	.245	.4725	1.25	2.25	3.96	6.15
Dallas	.236	.....	.7165	.....	2.70	.....	.....
Denver	.16	.23	.414	.816	1.44	.....	.....
Detroit	.15	.25	.48	1.125	2.025	3.80	.....
Kansas City	.21	.335	.52	1.00	1.90	3.80	.....
Los Angeles(f.o.b.)	.2175	.2825	.5085	1.1865	2.034	3.69	.....
Minneapolis	.15	.21	.415	.95	1.72	2.85	3.75
Montreal	.30	.45	.75	1.95	2.60	.....	7.20
New Orleans	.16	.....	.51	.....	1.90	.....	.....
New York	.1665	.259	.4995	1.325	2.385	.....	.....
Philadelphia	.081	.126	.243	.65	1.17	2.376	4.615
Pittsburgh	.09	.18	.27	.62	1.22	2.45	3.68
St. Louis	.09	.205	.369	.945	1.62	3.20	4.44
San Francisco	.175	.25	.45	1.05	1.80	3.00	4.50
Seattle	.175	.275	.54	1.20	2.00	3.00	5.50

CLAY DRAIN TILE—Per 1,000 lin.ft., f.o.b., in carload lots, 4 in.:

Atlanta	$50.00	Los Angeles	$60.00
Birmingham	50.00	New Orleans	40.00
Boston	50.00	New York	35.00
Chicago	40.00	Philadelphia	36.00
Dallas	65.00	Pittsburgh	80.00
Denver	75.00	St. Louis	40.00
Detroit	50.00	San Francisco	67.50
Kansas City	60.00	Seattle	45.00

Miscellaneous

LINSEED OIL—Raw, in 5-bbl. lots, per lb., f.o.b.:

Atlanta (per gal.)	$0.80	Minneapolis	$0.099
Birmingham	.066	Montreal (per gal.)	.49
Boston (per gal. delivered)	.65	New York	.089
Dallas (per gal.)	.555	Philadelphia	.075
Denver	.11	Seattle (per gal.)	.69
Kansas City (per gal.)	.80	St. Louis	.103
Los Angeles	.0775	San Francisco (del)	.1125

WHITE LEAD—In oil, per 100 lb. keg., f.o.b.:

Atlanta	$12.50	Montreal	$ 9.54
Birmingham	12.50	New Orleans	11.00
Boston	11.00	New York	11.00
Dallas	12.00	Philadelphia	9.90
Kansas City	11.25	Seattle	11.50
Los Angeles	11.25	St. Louis	11.00

CHEMICALS—Water, sewage treatment, road work, f.o.b., carlots, New York:

Bleaching powder, in drums, f.o.b. works, per 100 lb.	$1.75@2.00
Calcium chloride, 77-80%, flaked, in 400-lb. drums or 100-lb. moisture proof bags, f.o.b. works, freight equalized with points of competion, per ton	19.50
Chlorine, cylinders, per lb. delivered	.05½
Silicate of soda, in drums, f.o.b. works, per 100 lb.	1.65
Soda ash, 58%, in bags, per 100 lb.	1.22½
Sulphate of aluminum, in bags, per 100 lb.	1.25@1.40
Sulphate of copper, in bbl., per 100 lb.	3.25

MANILA ROPE—The number of feet per pound for the various sizes is as follows: ¼-in., 6-ft.; ½-in., 1-in.; ¾-in., 4-ft., 5-in.; 1-in., 3-ft., 8-in.; 1¼-in., 2-ft., 5-in.; 1½-in., 1-ft., 8-in. Following prices are per lb. for ¼-in. and larger, delivered in 1,200 ft. coils:

Atlanta	$0.1575	Kansas City	$0.21
Baltimore	.225	Los Angeles	.16
Birmingham	.20	Minneapolis (f.o.b.)	.155
Boston	.155	Montreal	.14
Chicago	.175	New Orleans	.165
Cincinnati (f.o.b.)	.21	New York	.145
Cleveland	.20	Philadelphia	.15
Dallas	.18	St. Louis	.145
Denver	.165	San Francisco	.145
Detroit	.195	Seattle	.155

BUILDING PAPER—Black, 50-lb. per roll of 500 sq.ft., in carloads, f.o.b., producing point $2.20

SLATERS FELT—In carloads, per roll, f.o.b., producing point $0.60

PREPARED ROOFING—Per square, f.o.b., in carload lots:

	Single Shingles*	Strip Shingles†	Rolls‡
Atlanta	$5.00	$5.35	$1.75
Boston	5.76	3.18	1.41
Dallas	4.50	3.75	1.75
Detroit	6.25	6.50	1.85
Montreal	6.40	6.20	2.68
New Orleans	5.50	5.40	1.95
New York	6.50	6.25	2.50
Philadelphia	4.40	4.20	1.65
Seattle	8.75	5.50	2.25
St. Louis	5.76	4.76	1.41

*Slate finish, sufficient to cover 100 sq.ft. ‡Slate surfaced, in rolls weighing 85 to 90 lb. †4 in 1, hexagonal shape, with Underwriters' label.

ROOFING MATERIALS—In carload lots, f.o.b.:

	Asphalt Felt, per 100 Lb.	Tar Felt, per 100 Lb.	Asphalt Coating, per Gal.	Tar Pitch,* per Ton
Atlanta	$44.50†	$44.50†	$0.45	$22.50
Boston	2.40	2.40	.50	23.00
Dallas	2.75	2.75	.65	34.00
Montreal	2.62‡	2.02‡	1.40	1.63**
New Orleans	.....	2.50	.....	22.50
New York	2.40	2.40	.34‡	28.00
Philadelphia	2.25	2.25	.33	20.00
Seattle	2.40	2.40	.55	27.90
St. Louis	2.52	.....	.28	26.00

*In 350 lb. barrels. †Per ton. ‡Per roll. **Per English cwt.

WINDOW GLASS—Discounts from latest jobbers list, dated Sept. 15, 1928 for sizes above first three brackets:

	Single Thickness		Double Thickness	
	A Quality	B Quality	A Quality	B Quality
Atlanta	85%	85%	85%	85%
Birmingham	89%	91%	89%	91%
Boston	88%	90%	87%	89%
Dallas	85%	85%	85%	85%
Denver	84@5%	86@5%	84@5%	86@5%
Kansas City	89@5%	89@5%	89@5%	89@5%
New York	87%	89%	87%	89%
Philadelphia	88%	90%	88%	90%
Pittsburgh	87%	89%	87%	89%
Seattle	90@10%	90@20%	90@10%	90@20%

EXPLOSIVES—Price per pound for dynamite delivered:

	Gelatin 40%	Gelatin 60%		Gelatin 40%	Gelatin 60%
Atlanta	$0.215	$0.2375	Los Angeles†	$0.1725	$0.1925
Baltimore	.21	.225	Minneapolis	.1725	.1875
Birmingham	.13	.1525	Montreal	.1675	.1925
Boston	.245	.27	New Orleans	.19	.22
Chicago	.17	.195	New York	.245	.2675
Cincinnati (f.o.b.)	.22	.245	Philadelphia	.215	.24
Dallas	.2125	.2475	St. Louis	.1375	.1525
Denver	.19*	.205*	San Francisco	.1575	.1725
Kansas City, Mo.	.2025	.2225	Seattle	.1525	.175

*F.o.b Louviers. †F.o.b. arsenal.

Lumber

LUMBER—Per M. ft., b.m., No. 1, Common, rough, in carload lots:

SOUTHERN YELLOW PINE

	1 x 6 In.* F.o.b.	1 x 6 In.* Del.	1 x 8 In.* F.o.b.	1 x 8 In.* Del.	3 x 12 In.† F.o.b.	3 x 12 In.† Del.	12 x 12 In.† F.o.b
Atlanta	$17.50	.....	$17.50	.....	$40.00	.....	$45.00
Baltimore	.....	$46.00	.....	$43.00	.....	$42.00	.....
Birmingham	18.00	20.00	18.00	20.00	20.00	22.00	30.00
Boston	25.00	30.00	26.00	31.00	59.00	64.00	59.00
Chicago	.....	.....	.....	.....	.....	62.50	.....
Cincinnati	.....	28.00	.....	28.00	.....	35.00	35.00
Cleveland	.....	19.00	.....	20.00	.....	26.00	29.00
Dallas	.....	35.00	.....	35.00	.....	50.00	52.50
Denver	.....	27.00	.....	27.00	.....	.....	.....
Detroit	30.00	32.00	30.00	32.00	32.00	32.00	45.00
Kansas City	30.00	.....	28.00	.....	47.50	.....	47.50
Minneapolis	.....	31.00	.....	31.00	.....	35.00	.....
Montreal	44.00	.....	45.00	.....	30.00	.....	.....
New Orleans	.....	18.00	.....	19.00	.....	30.00	.....
New York	22.00	24.00	23.00	25.00	50.00	52.50	50.00
Phil. No. 2(com.)	20.00	24.00	21.00	25.00	29.00	33.00	48.00
Pittsburgh	20.00	28.00	20.00	28.00	26.00	36.00	44.00
St. Louis	22.50	27.50	22.50	27.50	42.50	47.50	41.00

DOUGLAS FIR

	1 x 6 In.* F.o.b.	1 x 6 In.* Del.	1 x 8 In.* F.o.b.	1 x 8 In.* Del.	3 x 12 In.† F.o.b.	3 x 12 In.† Del.	12 x 12 In.† F.o.b.
Baltimore	.....	$48.00	.....	$43.00	.....	$58.50	.....
Boston	$22.00	27.00	$22.00	27.00	$32.00	37.00	$37.00
Chicago	.....	.....	.....	.....	.....	44.52	.....
Cincinnati	.....	.....	.....	.....	.....	42.50	42.50
Cleveland	.....	22.00	.....	23.00	.....	29.50	30.00
Denver	.....	27.00	.....	27.00	.....	48.00	53.00
Detroit	.....	.....	.....	.....	30.00	30.00	45.00
Kansas City	30.00	.....	33.00	.....	40.00	.....	45.00
Los Angeles	19.00	20.00	19.00	20.00	20.00	21.00	20.00
Minneapolis	.....	31.00	.....	31.50	.....	36.00	.....
New Orleans	.....	21.00	.....	21.00	.....	42.50	.....
New York	19.00	21.00	20.00	22.00	27.50	24.50	24.00
Philadelphia	.....	.....	.....	.....	.....	31.00	35.00
Pittsburgh	.....	.....	.....	.....	30.00	44.00	30.00
St. Louis	29.00	34.00	29.00	34.00	31.50	36.50	31.50
San Francisco	.....	17.00	.....	18.00	.....	19.00	19.00
Seattle	.00	10.00	9.00	10.00	11.00	12.00	12.00

*Form lumber, 16 ft. lengths. †Planks and timbers, 20 ft. lengths.

PILES—Prices of Nichols Bros., 90 West St., N.Y.C., per linear foot, pine, with bark on, f.o.b., New York; delivered from barge, 1½ to 2c. per ft. additional:

Dimensions	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.09	$0.145
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.13	.195
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.15	.215
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.185	.225
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.2025	.225
14 in.—2 ft. from butt	5 in.	80 to 85 ft.	.265	.375
14 in.—2 ft. from butt	5 in.	85 to 89 ft.)	.305	.442